COMBAT AIRCRAFT 132

Peter E Davies

F-102 DELTA DAGGER UNITS

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SERIES EDITOR TONY HOLMES

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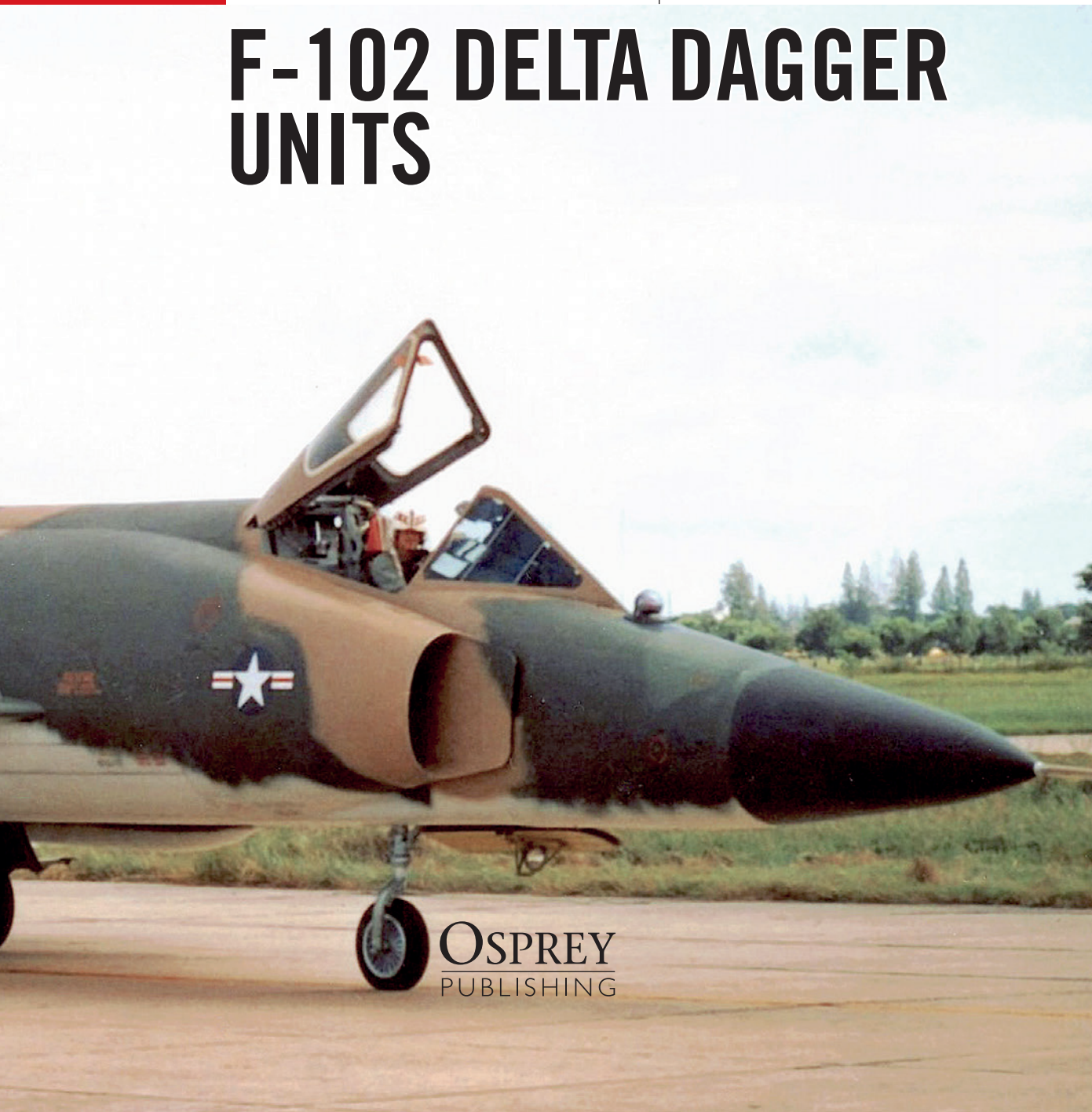

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CHAPTER ONE

A NEW SHAPE

For some aircraft manufacturers, certain structural features became their design signatures. For example, the Hawker or de Havilland vertical tails in the 1930s, Northrop's 1940s flying wings and Boeing's podded engines in the 1950s. For Convair, its delta wing was such a distinctive feature of many of its post-war designs that the company considered trying to patent the idea. It enabled the manufacturer to develop interceptors that served widely in USAF and Air National Guard (ANG) units for more than 30 years, create a prototype supersonic seaplane fighter for the US Navy (in the form of the YF2Y-1) and build the world's first supersonic bomber for Strategic Air Command (B-58 Hustler).

In the early 1940s Robert T Jones, an aerodynamicist at the National Advisory Committee for Aeronautics (NACA), recommended a thin delta wing for high-speed flight based on his research data which explored drag statistics and the sweep angles for this type of wing, with a rounded leading edge. However, some scientists doubted that delta wings would behave well at lower speeds, particularly for landing when no clear stall point would be indicated to the pilot. Others felt that controlling the wing's tendency to generate high roll rates in conditions of high lift would prove too challenging.

In 1945, when it became clear that German designers had moved well beyond such theoretical work, NACA technicians were able to study a captured German Lippisch DM-1 wooden glider – the first pure delta

A replica of the ramjet-powered, delta wing Lippisch P.13a, displayed at the Military Aviation Museum in Virginia Beach, Virginia. The pilot's cockpit was located in the thick vertical stabiliser and the coal-burning 'powerplant' was suspended behind the nose air intake. The aircraft, which never advanced beyond the design stage, was intended to be a cannon-armed interceptor for Luftwaffe Defence of the Reich fighter units charged with halting the USAAF and RAF heavy bomber armadas that steadily destroyed the country's infrastructure in round-the-clock raids from late 1943 onwards (*Wiki Commons/ Zackcbowen*)

wing aircraft. Its thick wing spanned 19 ft 8 in, with a leading edge sweep of 60 degrees. A disproportionately tall vertical tail which included the pilot's canopy extended along most of the 20 ft 9 in fuselage. Dr Alexander Lippisch's Delta 1 glider had flown in 1930, followed by a powered version with a 30 hp Bristol Cherub engine and the DFS 194 rocket-powered delta which, in 1937, became the 'Projekt X' progenitor of the Messerschmitt Me 163 rocket-powered interceptor.

By 1945 Lippisch, who was born in 1894 and served as an aerial photographer in World War 1, had already moved on to experiment with improved projects based on the DM-1. These included the ramjet- or rocket-powered P.13a and P.14 that were intended to reach speeds in excess of Mach 1.80. The scarcity of oil-based fuels in Germany towards the end of World War 2 forced designers to use a coal-burning ramjet engine with rocket boosters for the P.13a concept. The rockets would have accelerated the aircraft to 200 mph, at which point the granulated coal, in a rotating drum, would have been ignited by a gas flame. The gas that was subsequently produced by the flame mixed with high-pressure air to create thrust.

From 1941 Lippisch was greatly assisted by the high-speed wind tunnels developed in Germany that enabled test models to be subjected to Mach 4.4 airflow. As Allied troops advanced into Germany, a number of designers, particularly those involved in the Third Reich's cutting edge nuclear weapons and V2 programmes, were captured and moved to the USA in Operation *Paperclip*. Lippisch was among their number. His incomplete DM-1, captured at Prien along with large quantities of research documentation, was also shipped across the Atlantic.

NACA's 1946 tests with the imported DM-1 in its Langley Field wind tunnel, assisted unofficially by Lippisch, revealed many problems with stability, lift and drag associated with the thick wing. Papers based on the captured German research were made available to the Consolidated Vultee Aircraft Corporation (Convair), which was working on the USAAF's August 1945 requests for proposals for a supersonic point-defence interceptor (designated MX-813) and a long-range penetration/escort fighter. The company won the interceptor contract on 25 June 1946 and began work on two prototypes. The aircraft's role was similar to that performed by the Me 163 – a short-range, hard-hitting fighter that could climb to an altitude of 50,000 ft before engaging intruding bombers at Mach 1.75 (1165 mph). Its endurance for that mission would barely exceed six minutes.

Initially, Convair's design used a 35-degree swept wing, accepted at the time as the optimum sweep-back angle, combined with a V-shaped tail and rocket power. By May 1946 the initial MX-813/XP-92 design, armed with four T-31 20 mm cannon in its nose, was ready for USAAF inspection. Wind-tunnel tests showed that the MX-813's wing, spanning 31 ft 4 in, demonstrated poor low-speed characteristics. The subsequent use of a conventional tail unit was only a partial solution to these stability problems. Different wing configurations that progressed gradually towards a pure delta were examined, and Chief of Design Adolph Burstein finally preferred a 60-degree sweep delta wing, using data from Lippisch's research and the DM-1 tests in NACA Langley's wind tunnel. Delta-wing research by Michael Gluhareff at Sikorsky was also examined.

After working at the USAAF's Air Materiel Command at Wright Field, Lippisch himself was seconded to Convair in October 1946 as a consultant on the XP-92 design. His research convinced the company's chief aerodynamicist Ralph Schick that a tailless delta format would be preferable, as Burstein had thought. However, the Convair team strongly favoured a thin delta rather than the thick, subsonic airfoils used in the German designs. Simultaneously, Ed Heinemann at Douglas was working on Lippisch-inspired configurations for a project that would later emerge as the US Navy's jet-powered F4D Skyray interceptor, which first flew in January 1951.

The advantages of the delta compared with conventional swept or un-swept wings for supersonic flight were seen to be low transonic drag increase because the delta structure enabled a thinner wing and an increase in lift at speeds up to Mach 1. At high angles-of-attack the lift decreased gradually without inducing unwelcome stall-spin characteristics. It made trailing-edge flaps and a horizontal stabilizer unnecessary, although the wing did tend to act as a massive speed brake at high angles-of-attack – a characteristic that had to be considered as a disadvantage in aerial combat.

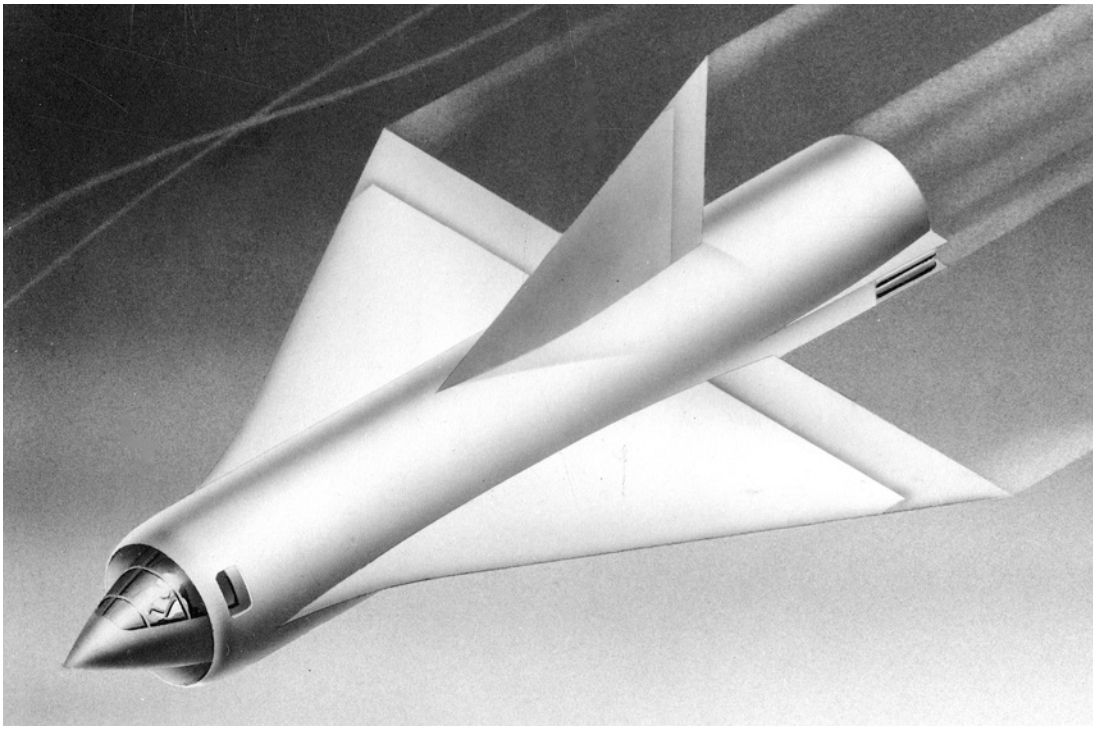
The long-chord wing root allowed a lighter structure with considerable fuel capacity and great rigidity. It prevented the 'warping' effect that was being encountered with the thin, swept wings used on many contemporary fighters that could cause adverse yaw or 'aileron reversal' – a condition in which operating the ailerons had the opposite effect to the intended one. Former F-102A pilot Col Shaun Ryan also flew the F-100 Super Sabre and described the inherent difficulties of the latter fighter's thin, 45-degree swept wing;

'The F-100 was faster on landing finals [than the F-102] but it flew and landed like an airplane should, except for one major difference – adverse yaw. At high angles-of-attack, such as those used for landing, if a wing dropped in a "Hun" [F-100] you picked it up with the rudder, not ailerons. If you used ailerons the aircraft would go opposite to the control input. This was much more noticeable in a high-G turn where, if you used ailerons to steepen the bank angle, the plane could snap roll in the opposite direction. You flew high-G manoeuvres [in the F-100] with your elbows braced against the canopy rails to ensure that the ailerons stayed in the neutral position.'

DELTA DATA

A mock-up for the 'augmented rocket' version of the XP-92 interceptor was built in 1948 with a delta wing swept at 60 degrees. At that stage it had a simple cylindrical fuselage, including a cockpit in a pointed nose section that was located centrally in the air intake for the innovative engine. This was a ducted ramjet motor powered by gasoline and boosted by a number of internal rocket chambers. In appearance it echoed the fuselage structure of the British Miles M.52 of 1945 and the French Leduc ramjet prototype more than the Lippisch DM-1, but it had a thin swept wing and V-tail instead of the straight flying surfaces of the planned Miles supersonic jet.

To avoid being sucked into the ramjet in an emergency bail-out, the pilot's cockpit section would have been jettisoned with the rest of the



An artist's impression of the XP-92 around the time of its April 1948 mock-up construction, by which point delta wings and a single vertical stabiliser had replaced swept wings and a butterfly tail. The cockpit had a forward-hinged transparency above the nose 'spike'. Massive drop tanks, more than half the length of the aircraft, were suspended on underwing pylons. Booster rockets were located under the tail (*Terry Panopalis*)

forward fuselage, rather like the contemporary Douglas D-558 and Bell X-2 research rocket aeroplanes. Launched from an eight-wheeled trolley that would have provided liquid oxygen and water/alcohol fuel supplies for the take-off run, the aircraft could then have drawn fuel for its climb to interception altitude from two huge, underwing drop tanks that could be parachuted down for re-use.

After several mock-up inspections, the USAF (which had been established as an independent branch of the US Armed Forces on 18 September 1947) cancelled the XP-92 in June 1948 largely due to concerns about its unproven rocket-ramjet and doubts about its forecast performance. Instead, an earlier proposal for a 'flying mock-up' for the XP-92, suggested in 1946, was revived as the XP-92A. Intended solely to prove the delta wing concept for the XP-92, this much simpler design, using a conventional tail and a delta wing swept at 60 degrees, was sanctioned in November 1946. To save development time two prototypes (referred to internally as the Model 7-002) were to use conventional turbojet power and a high proportion of hardware from other existing aircraft in an airframe that retained the XP-92's delta wing, swept at 60 degrees, and a large, delta-shaped vertical tail. It had a conventional cockpit arrangement with a heavily reinforced canopy, a single air inlet in the nose and a standard tricycle undercarriage.

Using a delta wing required a complete re-think of the flying controls which were traditionally based on a system using ailerons, elevators and a rudder. As Col Ryan explained, the F-102 and its XF-92A predecessor 'did not have separate ailerons and elevators but a combination of the two referred to as "flaperons" [or "elevons"]. They acted as both ailerons and

elevators, with both sides operating together as elevators. If you needed roll input, they would deflect separately. I never felt that the plane flew any differently because of this.' Convair devised this system and operated it with 100 per cent hydraulically-boosted, irreversible flight controls, intended for the XP-92 and used for the first time in an aircraft.

The Model 7-002s were allotted the serials 46-682 to 46-684 but only the first of these was required as the USAF no longer saw the XP-92A (XF-92A after September 1947) as anything more than a one-off research vehicle to explore the delta concept. An airframe was completed by December 1947 and subjected to extensive full-scale wind tunnel tests. In January 1948 an Allison-built General Electric J33-A-21, derived from the British Derwent turbojet and used in the Lockheed P-80 Shooting Star, was installed. It was fed by a bifurcated intake, with air passing on both sides of the cockpit. Flight tests soon showed that in the XF-92A the engine was barely adequate. Indeed, it could not provide enough power for the aircraft to climb out of ground effect with its undercarriage lowered.

The stubby jet was sent to Muroc Air Force Flight Test Center in April 1948 and Convair's chief test pilot, Ellis 'Sam' Shannon, flew it on 18 September after initial taxi runs that began in May. Following its initial brief two-mile 'hop' in June 1948, the silver delta was equipped with a more powerful Allison J33-A-23 and a revised tailpipe, together with an improved canopy. Shannon and Bill Martin made 47 flights, testing low-speed characteristics and diving the aircraft at increasing velocity, reaching a maximum speed of Mach 0.925.

The pilots found the XF-92A's light, hydraulic flight controls to be extremely sensitive, with Sam Shannon admitting that they 'left much to be desired' and made the aircraft 'very difficult to fly straight and

White paint and 'X' calibration marks were applied to XF-92A 46-682 for its flight tests, although the elevons and rudder were usually unpainted – the aircraft reverted to metal finish after its use by NACA. On its 22 July 1953 flight, the jet's wing fences (which had been installed with a different profile for the 3 July flight) were distorted by the airflow and had to be revised. They were removed for the aircraft's final flight in October 1953. The extended rear fuselage for the afterburning J33-A-29 engine, installed in 1950, needed a retractable support strut to counteract the XF-92A's centre of gravity problems on the ground (*USAF*)

level' – the smoothest flightpath could be achieved by not touching any of the controls. Often, light movements with the control column to alter pitch would operate only one elevon by a fraction of a degree, inducing roll instead of pitch. Despite extensive modifications little could be done to alter this behaviour, with the sensitivity being attributed to the control system rather than to any inherent delta wing characteristic.

The jet was also unusually susceptible to crosswinds above 25 mph on take-off. It had to be aligned almost directly into the wind to avoid that problem, and if the wind changed, a flight could be cancelled. The manufacturer's Phase I tests, which were intended to prove the delta wing with a view to building a fighter with that configuration, proceeded rather slowly, and the USAF claimed the aircraft on 14 May 1949. Shannon and Martin continued Phase I tests up to 26 August, however.

Majs Chuck Yeager and Frank 'Pete' Everest were the USAF pilots assigned to the aircraft for Phase II. Yeager found it a 'tricky' aeroplane, although he managed to reach Mach 1.05 on his second flight. He completed the event by landing the jet at only 67 mph after finding that it would remain in flight pitched up at a 44-degree angle-of-attack. Yeager enthused about the delta wing and the impossibility of stalling or spinning it. In a later excursion in May 1950 he was slightly injured when the jet engine failed on take-off and he had to skid it to a halt on the dry lake bed to avoid a collision.

Maj Everest was unhappy about the XF-92A's stability, including a tendency to pitch up in high-speed, tight turns. However, it was virtually impossible to spin and it resisted nose-down pitching if the wing had stalled. Various wing fence installations were tested in 1953 to control the nose-up pitching in certain flight situations such as a turn at high speed that could subject the airframe to 8 g forces, but the wing's inherent strength, stall-free characteristics and useful internal space for fuel were considered proven and its low wing-loading increased the aircraft's maximum altitude. Everest also pushed it a little way past Mach 1 in a steep dive and found that the delta wing made the transition from subsonic to supersonic speed more easily than other types of wing.

The XF-92A's performance was considered to be inadequate, so the USAF funded installation of a J33-A-29 with an afterburner in an extended rear fuselage. Engine thrust was thereby briefly increased from 5200 lb to 7500 lb, which was intended to increase its level speed to at least Mach 0.98 and its maximum altitude to 50,000 ft. The modification programme, including a coat of white paint to improve visibility in flight, began at San Diego in May 1950 and kept the XF-92A grounded for more than a year. Despite the installation of the J33, the aircraft's performance continued to be disappointing. The afterburner routinely flamed out at around 38,000 ft and caused numerous maintenance problems and overheating, requiring six engine changes in 19 months. There was hardly any increase in maximum speed, although Everest dived it to Mach 1.01 in February 1953.

Other notable test pilots to fly the first delta-winged aircraft included Fred Ascani, Albert Boyd, John Nash, Jack Ridley and Kit Murray, all of whom would take major roles in the development of a new generation of USAF fighters and bombers as flight-testers and engineers.

In February 1953 NACA took over the aircraft and in April installed a J33-A-16 engine, giving an extra 900 lb of thrust. Test pilot Scott Crossfield made 25 more flights, taking the little delta's total to 119. After his initial flights Crossfield declared it the 'worst-flying airplane built in modern times that I know of – a hopeless mess, a patchwork quilt of fixes upon fixes'. Among its perceived problems were lack of power, excessive weight, poor brakes and the need to replace the engine after virtually all of its early flights. The XF-92A's over-sensitivity to control movements also remained a persistent problem.

Nevertheless, Crossfield did acknowledge that the jet generated enough data to make the future F-102 a feasible aeroplane with acceptable stability in flight. Its handling qualities had proved to be far better than many aerodynamicists had forecast and the aircraft had not automatically flipped over onto its back when landing at a high angle-of-attack as some had predicted.

However, Crossfield's first encounter with the white delta – a fast taxi run – almost ended in a fiery crash. Heading for the base area, he accelerated enough to lift the fully fuelled aircraft briefly into the air. Crossfield then allowed it to sink back onto the runway again, whereupon he found that the brakes had little effect as he headed towards the built-up area of the Muroc base. He could see a shallow hill ahead and he decided to run the aircraft onto it, retract the landing gear and turn on the fire extinguishers before leaping out. At the last moment Crossfield saw a small service road to the left, jammed on the left brake (which fell off) and steered the XF-92A along it as the tyres caught fire, eventually bringing it to a halt.

On its final flight, with Crossfield in charge, a nose-gear strut collapsed while taxiing, ending the jet's useful career on 14 October 1953. The aircraft had by then been equipped with a drag 'chute, which was being tested for use in the YF-102. It also had a series of wing fence types fitted, some of which improved low-speed handling sufficiently for fences to be included in the F-102 design. In the wake of the taxiing accident, the USAF opted to avoid a $50,000 repair bill and the cost of a new high-altitude afterburner as the YF-102 was about to begin flight testing. The XF-92A was duly placed in storage and subsequently displayed in the National Museum of the US Air Force at Wright-Patterson AFB, Ohio.

The XF-92A was sufficiently futuristic in appearance for it to be used in two 1950s Hollywood films – as a 'MiG-23' in the John Wayne movie *Jet Pilot* (although the footage was not used) and in *Toward the Unknown*, a William Holden epic about experimental test flying made at Edwards AFB, California. Its 62 flying hours over five years of tests yielded enough data to persuade the USAF's Air Materiel Command to go ahead with its first delta-wing jet fighter project, the F-102, which became Convair's principal production item and equipped the USAF's interceptor squadrons for more than 15 years. Data from this early delta research also assisted designers at Douglas with the company's A-4 Skyhawk and F4D Skyray, while parallel research into tail-less fighters with elevon and rudder flight controls resulted in the less successful Vought F7U Cutlass.

CHAPTER TWO

DRAWING DAGGERS

'Yellow Canary' bulges on the rear fuselage helped to control airflow over the rear section of the first YF-102A, reducing supersonic drag. Apart from the extended vertical stabiliser and air intake ramps, most of the external features of the production F-102 were at last defined with this 1955 version (*USAF*)

Increasing concern about the possibility of attacks on the US mainland by long-range Soviet strategic bombers with nuclear weapons made the development of supersonic interceptors a main priority in the post-World War 2 period. Western air forces including the USAF were equipped with subsonic fighters armed with guns, free-flight air-to-air rockets and in a few cases the earliest infra-red (IR) homing missiles. Despite being produced in considerable numbers and distributed at bases around the periphery of the US continent, their relatively slow speed and short-ranging armament meant they could not be relied upon to intercept every incoming intruder before they released bombs or stand-off weapons. Destruction of a major city required only one or two bombers to penetrate the defences, so every intruder had to be intercepted.

With the existing North American F-86 Sabre and Lockheed F-94 Starfire fighters of the early 1950s that was certainly not happening in practice alert interceptions with Boeing B-47 Stratojet and B-52 Stratofortress 'targets'. The bombers' performance was similar or superior to the fighters' and their electronic countermeasures could often jam the interceptors' fire control radar, compelling them to use visual gunsights. In some cases, Northrop F-89 Scorpion squadrons achieved interception rates below 20 per cent against waves of B-47s. The underpowered F-89, weighing about as much as a McDonnell F-101B Voodoo but with less than half the power, lacked the acceleration and rate of climb to catch the jet bombers.

Fighter designers attempted to compensate for the low thrust and response times of contemporary jet engines by adding secondary rocket power for a short period of supersonic dash to the target. In the early 1950s the British Saunders-Roe SR.53, the Republic XF-91 Thunderceptor and, later, the Dassault Mirage IIIC relied on this mixed power combination, but their short-range interception capability was rapidly replaced by improvements in ground-to-air anti-aircraft missiles. Defence planners' priorities could then shift from short-range point-defence interceptors to longer-ranging, radar-equipped, all-weather fighters capable of carrying a missile armament greater distances in order to meet incoming enemy forces. By January 1949 the USAF was already planning the '1954 Interceptor', its Weapons System 201A (WS-201A) requirement being issued to manufacturers for such an aircraft.

The term 'weapons system' described a completely new way of tackling the complexity of urgent defence equipment procurement programmes, and it would become standard practice in the 1950s. Such a requirement included every aspect of a fully integrated 'system', from the aircraft with its engine and armament to the ground support equipment and manuals needed to keep it in service and train those who supported it. Above all, the aim was to minimise the need for costly delays due to design faults in prototypes or inadequate off-the-shelf equipment.

The normal, lengthy design process involving a series of prototypes that were gradually tested and modified until a production standard could be agreed was replaced by an approach in which the aircraft would theoretically be 'right first time'. This involved careful prediction of aspects such as the dimensions of future guided missiles that would have to be accommodated internally to minimize drag, additional avionics or potential changes in powerplants. The entire programme was to be managed as a whole so that the last aircraft to leave the factory would be essentially the same as the first. It was therefore particularly ironic that the F-102 would require a more complete re-design during its production cycle to achieve its design performance than any other contemporary aircraft.

In practice, the idea that production standard tooling and drawings could be perfected before any aircraft flew was widely seen to be excessively optimistic. However, its essential features were incorporated in a compromise plan devised by Lt Gens Orval Cook and Laurence 'Bill' Craigie, who were the USAF's Deputy Chiefs of Staff for Development. In the Cook-Craigie plan some of the production-style tooling was used from the outset, but for a gradual run of production in which the first few aircraft were assembled and any minor modifications were incorporated in the tooling for subsequent aircraft. Because there was no prototype, the first two production examples would be labelled YF-102s rather than XF-102s. All being well, more of the production tooling would then be brought into use, minimising delays. Obviously, if major problems arose there would be considerable waste involved in making new production tooling and drawings.

As the first subject of both the Weapons Systems concept and the Cook-Craigie plan, the WS-201A (F-102) had much at risk. Its designers had to rely on performance predictions derived from wind tunnel test data, and crucial parts of that information proved to be inaccurate.

In the end, both the aircraft and MX-1179 electronics programmes were to stray so far from the original plans that much of the 'weapons system' basis of the contract was far from being realised. Nevertheless, a principle was established that would influence the majority of future aircraft production.

FIRE CONTROL

The innovative nature of this project was emphasised by the use of two project numbers – MX-1554 for the aircraft itself and MX-1179 for the complex electronic fire control system (FCS) for its armament. The Hughes Aircraft Company received the MX-1179 contract in October 1950, *before* the award of a contract for the aircraft that would rely on the equipment. Westinghouse, General Electric and other firms were potential contenders but Hughes was the established supplier of the Falcon series of air-to-air missiles and the E-1 automatic, radar-directed FCS used in previous USAF all-weather interceptors such as the F-89 Scorpion and F-94 Starfire.

As the leading exponent of airborne interception technology, Hughes was considered to be able to develop a far more advanced FCS in the form of the MA-1, with a proposed 1953 in-service date. The result was a system weighing almost 2000 lb, including an advanced search radar, vacuum tube-powered weapon control electronics and autopilot links, all housed in pressurised air-conditioned compartments.

Hughes' E-1 and E-4 (used in different versions for the F-86D and F-89D, and the basis of the new MA-1 system) were collision-course systems that used radar to position the interceptor in a beam attack on the intruder aircraft, predicting its course and the moment when the fighter's armament could be fired to cut off the bomber's forward progress. Multiple unguided rockets were then released to bracket the point in the air that the target was about to reach, thus avoiding the need for a time-consuming tail-chase attack. Early radars had been so unreliable that a navigator was usually required (as in the F-89 and F-94) to operate the FCS and 'steer' the pilot into a curve-of-pursuit or 'tail chase' interception.

For WS-201A, a far more effective semi-automatic system, preferably controlling guided missiles, was required so that it could be used in a single-seat fighter. Convair anticipated that the complexity of guiding a supersonic missile-launching fighter against a high-performance bomber would become an automated process, with the pilot as a weapons systems manager. British defence planners had already advanced another step and abolished the pilot altogether.

There was more intense competition for the airframe contract, with initial MX-1554 submissions from six companies in January 1951, later reduced to three. Lockheed's entry was quickly excluded to simplify the process, although it emerged later as the F-104 Starfighter. Republic offered three proposals, and its principal concept, Alexander Kartveli's AP-57 (re-designated as the XF-103) was far in advance of the rival Convair bid in many ways.

Constructed of titanium to withstand the surface heat that its Mach 3 speed would generate, the fighter was meant to reach an altitude of 80,000 ft. However, its intended Wright J67 engine (a Bristol Olympus

derivative) never materialised and no suitable alternative was available. The engine was meant to be connected to an RJ55-J-1 ramjet, increasing its power to a then-unprecedented 40,000 lb thrust for speeds in excess of Mach 2.5 with the basic jet engine shut down. Its only common ground with the Convair designs was the use of delta shapes for the wings, but it also had a delta tailplane and vertical stabiliser, together with a folding ventral fin. The wing could be tilted to increase the angle-of-attack for take-off and landing.

Further drastic innovations appeared in the XF-103's cockpit, from which the pilot had visibility only through side windows and (at the USAF's insistence) a forward-looking periscope rather than a cockpit canopy. In an emergency the pilot could be enclosed in an early version of the supersonic escape capsule, which the USAF also felt was necessary to provide a feasible method of surviving supersonic ejection in its future high-performance aircraft. A later version appeared in the Convair B-58 Hustler.

The XF-103 design, although cancelled at the mock-up stage in 1957, re-emerged briefly as a possible test-bed for the weapons system of the equally advanced, all-delta North American XF-108 Rapier interceptor project. The Mach 3 Rapier was a proposed replacement for Convair's F-102 Delta Dagger and its successor, the F-106 Delta Dart, but its burgeoning costs and technical problems brought about its cancellation in 1959.

INTERIM INTERCEPTOR

Convair's proposal, the Model 8 (F-102), was derived directly from the single-seat XF-92A (Model 7), and the relative success of the latter convinced the USAF that a developed version could be ready to meet its '1954 Interceptor' deadline. However, by 1951, it seemed unlikely that the 1954 in-service deadline could actually be met. Nevertheless, the USAF still saw the Convair proposal as its best option. A Phase 1 order was therefore issued on 11 September 1951 for an aircraft to meet the USAF's MX-1554 performance requirements, which were significantly more feasible than the XF-103 goals at that time.

Maximum speed was to be Mach 1.88 and the aircraft had to climb very fast to reach an operational altitude of 56,500 ft within a 375-mile combat radius. Short take-off and landing distances were mandatory, together with high manoeuvrability and guided missile or free-flight rocket armament.

At that time, partly due to uncertainties about the aircraft's choice of engine, the Model 8 became part of a more ambitious scheme whereby it would be the 'interim' WS-201A interceptor, or F-102A. A more advanced version in the form of the WS-201B would later become the 'ultimate interceptor'. That aircraft, which would fulfil the USAF's requirements more exactly, eventually emerged as the F-106 Delta Dart. It envisaged buying small numbers of the interim F-102A as a stop-gap until the F-102B was available. In fact, delays and policy changes meant that the eventual total purchase of F-102As would be three times greater than the F-106 order.

A further addition to the programme in September 1953 was the WS-201L, or Model 8-12, which would satisfy the USAF's need for a two-seat trainer aircraft that could be used to prepare pilots for the

The second YF-102A-17-CO (53-1788) flight-tested the interim Hughes MG-3 FCS, parts of which are visible here. Upgraded to operational standard, the aircraft later flew with the South Carolina ANG and was eventually displayed at McEntire ANGB, South Carolina, and then at Fort Walton, Florida (*Terry Panopalis*)

interception mission more satisfactorily than its usual T-33 trainers. This variant became the mission-capable TF-102A, although initial orders for it were delayed until July 1954 while problems with the single-seater were addressed.

While the XF-92A had given Convair a head start in delta design, there were still many unresolved problems concerning control systems and supersonic drag to be tackled. The delta format was already proving very influential, however. In April 1953 Northrop proposed a 'Delta Scorpion' successor to its F-89. This was a totally new design with twin, podded, 13,200 lb thrust J67 afterburning engines, a conventional tail unit and Mach 1.9 speed.

An F-102 mock-up was constructed during 1952 and pre-production work began on the first of two YF-102As (52-7994 and 52-7995) in December 1951. Under the Cook-Craigie 'buy before you fly' plan another eight service test examples would follow, with limited production of the rest of the initial batch of 42 to begin in April 1954. Definitive service examples were not expected until late 1955, which was also the extended completion date for the Hughes MX-1179 system.

Conscious that the F-102 project was still an urgent one, the USAF told Hughes to devise and supply an interim system based on the E-9 (or MG-3) used in the F-89. That system had to be modified as the E-9A, with an autopilot for single-seat use, and it evolved into the MG-3 incorporating the MJ-1 Automatic Flight Control System, an AN/ARC-34 communications set and an AN/ARR-44 data link system. This package was intended to give results that would approximate to the delayed MX-1179. It could control either lead-pursuit interceptions with unguided rockets or the preferred collision course method firing Falcons. Unfortunately, the MG-3 was heavier than the predicted MX-1179 weight limits.

When the USAF asked for additional auto-landing capability and a data link set to connect the aircraft with the SAGE (Semi-Automatic Ground Environment) radar guidance network, the system thereby became the MG-10 in 1958 and the aircraft consequently suffered further weight increases.

SAGE was a hugely expensive network of computers and radar stations built to coordinate North America's detection of impending air attack, and the air defence response to such an intrusion. Based on the IBM-manufactured AN/ASQ-7, designed by the Lincoln Laboratory, and the most powerful computer of its time, SAGE was activated in 1958 with a number of massive direction centres, each operating an AN/ASQ-7.

The direction centres coordinated the tracking of incoming targets and instructed interceptor bases (and, later, CIM-10 Bomarc missile sites) to launch fighters. The network, developed by the Burroughs Corporation, automatically updated the autopilots of interceptors as they followed their interception routes, minimising the pilots' task. The F-89, F-94 and F-101B were equipped to handle SAGE, and it was logical to add that capability to the F-102 and its successor, the F-106 Delta Dart. NAGE was its European equivalent for NATO aircraft.

The fourth of eight YF-102 Model 8-82s, 53-1782 was assigned to the AFFTC, whose patch was later applied to its fuselage. The 'barrel' fuselage and heavily framed canopy changed radically for the YF-102A version. The contours of the air intakes, here with swept back leading edges, were modified several times before the definitive production profile was established (*AFFTC*)

As the YF-102 took shape, some major structural changes to its XF-92A template were needed to produce an operational interceptor. In order to accommodate the radar and FCS in the F-102's nose, twin air intakes on the fuselage sides replaced the single nose intake of the XF-92A. The J33 engine was to be replaced by a 15,000 lb thrust Wright J67 (British Sapphire), although delays in developing that engine eventually prompted a fall-back plan to use the US Navy-sponsored Westinghouse J40 instead. Early versions of the J40 showed it to be underpowered and flawed in design, limiting its use to a disastrous period in McDonnell's F3H-1 Demon carrier-based US Navy fighter.

For the YF-102, the J40 was speedily replaced by Pratt & Whitney's exceptional J57 turbojet, which proved fundamental to the success of many 1950s US designs. It was the first American jet engine to develop 10,000 lb thrust and power a level-supersonic aircraft when installed in the F-100 Super Sabre. The J57 was smaller than the J40, and its 14,800 lb thrust exceeded the latter's estimated power by 1000 lb.

There were two hydraulic systems, a primary system for the flying controls and a back-up secondary system that also powered the landing gear and other accessory equipment. A ram-air turbine (RAT) could be extended in order to power the flight controls in an emergency as long as hydraulic fluid had not been lost and the aircraft had at least 175 mph of airspeed. For the airframe Convair used machined light alloy skins and frames. The tapered skins formed integral tanks in the wing for all the internal fuel. The large J57 engine, the long internal bay for six Falcon missiles and the MX-1179 systems left no fuel space in the fuselage, so Convair took advantage of the delta wing format's large but shallow internal space. The wing also housed an innovative de-icing arrangement (deleted for production aircraft) whereby hot engine bleed air was blown through tiny tubes in a sintered alloy surface.

In only 18 months from the beginning of detail design the first YF-102 (52-7994) was completed. In addition to its Convair title – Model 8-80

– the aircraft acquired the official but seldom-used name Delta Dagger in 1957, rather than the initially suggested 'Machete', to emphasise its most distinctive design characteristic. Twice as heavy as the XF-92A and 25 per cent larger, the first YF-102 was rolled out on 2 October 1953. It still strongly resembled the XF-92A in many ways. Wrapped in tarpaulins, the stumpy, 52 ft long silver jet was taken from San Diego to Edwards AFB by road in September 1953.

Convair's chief project test pilot Richard L Johnson (who had previously flown P-47s with the 57th FG in World War 2 and also set a world speed record in the F-86A in September 1948) made the YF-102's first flight on 24 October 1953. The test programme soon revealed the jet's mediocre performance, with major aerodynamic problems arising as the aircraft was pushed beyond Mach 0.9. Severe buffeting and yawing occurred throughout the nine days of testing that followed. Then, on 2 November, the engine flamed out on take-off with the aircraft at a high angle-of-attack, causing a wheels-up crash-landing that wrote 52-7994 off.

The second Model 8-80 YF-102 (52-7995) was not ready until 11 January 1954. Two weeks after its first flight, Sam Shannon, test pilot for the XF-92A, coaxed it slightly past Mach 1.05 in a dive on 28 April, experiencing extreme instability in doing so. He established that the new aircraft was stubbornly limited to Mach 0.98 in level flight, and also reported that it would not climb beyond 48,000 ft – a full 8500 ft short of its intended altitude. 52-7995's performance at that stage was slightly inferior to radar-equipped versions of the F-86 Sabre that were already in service and it clearly fell far short of the USAF's Phase 1 requirements for the programme.

Convair had made extensive use of Alcoa and Wyman-Gordon heavy-press equipment to forge entire fuselage frames as a way of saving weight and cutting the time required to rivet parts together in what was otherwise a fairly conventional airframe structure. As part of the contract the first production and pre-production aircraft were already being assembled on the assumption that the design would be almost acceptable for service use from the outset. More than 32,000 production tools had been made, costing almost $40.5m, and it now seemed likely that the design would prove to be a failure, leading to cancellation like many other advanced projects of its time.

While production aircraft began to emerge from the factory in a configuration that could not achieve the required performance, Convair was very fortunate in being handed a solution by NACA. Doubts about the YF-102's supersonic performance had been raised during wind-tunnel tests at NACA's Langley Research Center in early 1953. Two years earlier its Assistant Director, John Stack, had devised a transonic wind tunnel at the Langley Laboratory, and one of its scientists, Richard T Whitcomb, was able to study airflow patterns on aerodynamic models at supersonic speeds.

While analysing the wind tunnel data at Langley, NACA aerodynamicist Richard Whitcomb noticed that in addition to shock waves building up around the aircraft's forward fuselage at high speeds, additional shock waves were forming at the rear of the wing and fuselage, holding the aircraft back. He had already noticed this phenomenon in previous tests and wrote a 1952 research memorandum on what he called Area Rule.

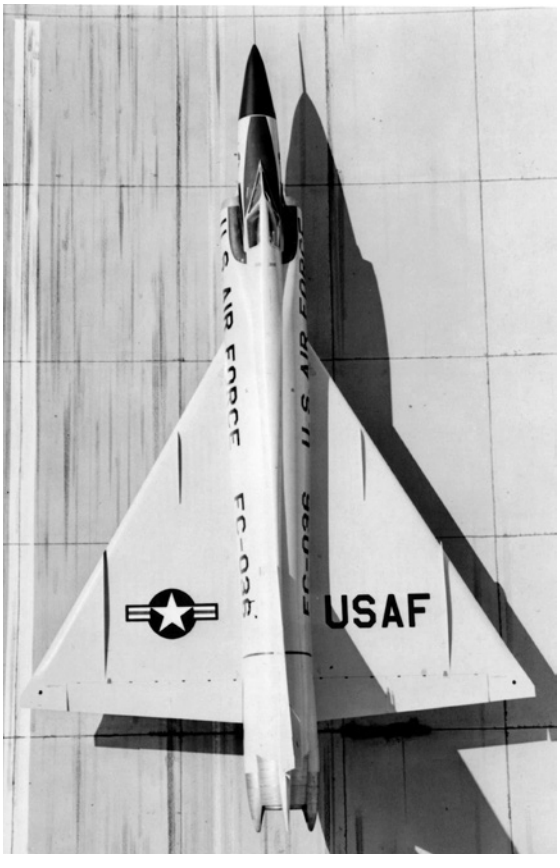
Whitcomb realised that the fuselage shape was the key to ensuring the smooth passage of airflow without loss of energy due to drag. He discovered that transonic drag could be greatly reduced if an airframe's complete cross-section could be varied to form a smooth curve from nose to tail.

Whitcomb calculated that the cross-section of the fuselage should be formed in such a way that it was narrowest where the wings met the fuselage and wider around the junction with the trailing edge of the wing. The long wing-to-fuselage joint of a delta wing obviously complicated the problem of evening out the cross-section.

For the early F-102, its original short, straight fuselage profile combined with the large delta area produced considerable aerodynamic drag at transonic speeds, effectively ruling out supersonic flight despite having adequate engine power and an all-up weight of 26,000 lb – well below the operational figure. Future astronaut Neil Armstrong was one of the test pilots who flew the YF-102 before it was area-ruled. At that stage he considered it, 'Kind of a dog of an airplane' and 'not a lot of fun to fly'. It resisted his attempts to encourage it into supersonic flight.

Tests with a rocket-launched model and area-ruled F-102 models in the transonic wind tunnel verified Whitcomb's findings, and he worked with Convair to apply them to the YF-102. 52-7995 was duly given a longer, drooped nose that began to resemble the production F-102 version and two bulges on its rear fuselage to improve its aerodynamic profile for supersonic flight. More radical airframe changes were required, however. Clearly, nothing short of a substantial redesign of the entire fuselage would improve the situation. Grumman's F11F-1 Tiger swept-wing fighter had already been flown with area rule, allowing it to achieve supersonic speeds, and other aircraft, including Republic's F-105 Thunderchief, which had also suffered a supersonic speed deficit in its early prototype stages, were redesigned using Whitcomb's data.

After an 117-day effort, Convair submitted a revised design in August 1953, using Whitcomb's suggested reduction in the fuselage cross-section, graduated around the centre of the fuselage-wing joint – the potential reduction was limited by the cross-section of the engine and other internal contents. To provide the necessary cross-sectional increase to the rear fuselage, extra 'Yellow Canary' bulged titanium bodies were added to each side, extending past the tailpipe to delay airflow breakaway. The fuselage was also lengthened by seven feet to improve distribution of the airflow and the intakes were re-fashioned to contribute to an overall so-called 'Coke bottle' profile. Although a similar design principle would be used for the B-58A bomber, the USAF was already raising concerns in mid-1954 over Convair's predicted supersonic performance figures for its planned bomber in view of the YF-102's problems.



The final, area-ruled pure delta format of the production Delta Dagger is displayed here by 56-1036, an F-102A-55-CO. The black dots on the wingtips are formation lights (*USAF*)

For production, the airframe was broken down into sections, all of which could be virtually completed and equipped before being assembled into the final aircraft. Components were produced in batches of 150 and supplied to work stations in Plant 2 as required. Wings were made in half sections, with particular attention being paid to leak-proofing their internal fuel tanks with Scotchweld sheet adhesive baked on at 320°F, giving the aircraft a good reputation for fuel retention. Wing skins measured 96 x 250 inches, and they were automatically milled from Alcoa 2024-T86 aluminium alloy, treated to withstand 200°F and loads of 67,000 lb/sq inch.

The flying surfaces were also improved in this revised Model 8-90 version of the YF-102 even before area rule was applied. A thinner Case X wing was introduced, positioned three feet further aft. The wing's leading edge was cambered downwards and the tips were turned slightly upwards – both changes that increased lift and reduced drag at high altitudes. Four wing fences were added to control airflow over the wings. The vertical stabiliser was also moved back by three feet. However, these revisions, which, in themselves, did not improve performance without the addition of area rule, were not applied to the initial aircraft, ten of which (rather than two in the original plan) were ordered as YF-102 development airframes. The total initial order stood at 42 in June 1953, with limited production beginning in April 1954 and combat-ready examples becoming available in December 1955.

Continued wind tunnel-testing brought about further adjustments to the wing camber and another extension to the forward fuselage, taking it to 68 ft 5 in. This placed the cockpit further forward. By that stage the fighter was almost the same length as a B-17 Flying Fortress, while its six-compartment missile bay was longer than the Boeing's bomb-bay.

Standard irreversible hydraulic flight controls were used, powered by primary and secondary hydraulic systems. Flight testing would reveal problems with this arrangement in that if there was a malfunction in one of the systems it would cause control column and rudder or elevon movements that the pilot could not overcome. Sometimes hydraulic fluid in a pump could become overheated due to air in the system, or a fluid leak. It was also possible for small amounts of contamination in the hydraulic fluid to silt up the system, causing friction and heat in the control valves that could be further exacerbated by low pressure in the heat venting system. In any case, the un-commanded control movements could only be stopped by trying to bleed off hydraulic pressure by lowering the undercarriage or operating the speed brakes. Occasionally, none of these remedies stopped the aircraft's wild, random pitch and roll movements, leaving the pilot with no choice but to eject.

The pilot's forward vision was improved by slightly drooping the nose and the Zenith-manufactured radome. Overall weight increased by 3500 lb over the first YF-102. The intake ducts were changed again, a new canopy with less framing was fitted and the weight increase was offset by the availability of the J57-P-23 engine developing 16,000 lb of thrust. Stretched plastic was used for the first time for the canopy glazing rather than earlier acrylic material that tended to shatter when hit by a bullet or debris, causing immediate explosive decompression in the cockpit.

Although stretched plastic panes could still be holed by a bullet, the compressed internal air would escape slowly enough for the pilot to take some remedial action. The Pittsburgh Plate Glass windscreen panels were a sandwich of tempered glass and vinyl.

The initial YF-102s were a potential maintenance nightmare as most of the internal components were inaccessible without removing the engine. The general redesign greatly improved that situation, allowing components to be accessed through undercarriage wells, the weapons bay or new access panels. Four side-doors were provided for the forward avionics compartment, which housed about half of the MG-10's components.

In the F-102A cockpit the right section of the split yoke was used to control the aircraft and the independent left side operated the radar. The large radar scope, with its rubber hood to make the screen visible in daylight, dominated the upper instrument panel and restricted forward vision. The large standard flight instruments (airspeed, direction indicator, altimeter, course indicator, attitude indicator, and vertical velocity indicator) are grouped in front of the pilot (*Terry Panopalis*)

Thirty-two of the revised F-102As were included in the USAF's March 1954 order, with another 108 added in June, subject to proven enhancement of the aircraft's performance. The operational requirements at that time included a speed of Mach 1.23 (rather than the Mach 1.88 requirement in 1951) at 35,000 ft, a 375-mile combat radius and a service ceiling of 54,000 ft. From the initial production batch, four YF-102As with all the new airframe revisions – including area rule – were re-manufactured using little of the original production tooling, two-thirds of which had to be scrapped at huge expense. Major revisions to the production line were undertaken in an urgent programme that took only seven months to complete. The rest of the batch of ten subsonic models were completed without area rule and became part of the unprecedentedly large force of almost 50 early F-102s that comprised the pre-service test force for the USAF, Convair and NACA.

The first 'Hot Rod' YF-102A (53-1787) with the modifications was ready to fly on 20 December 1954. The following day Richard Johnson flew it to Mach 1.22 in smooth, level flight at 53,000 ft to the enormous relief of Convair staff. A 21 January 1955 flight reached higher to 55,130 ft.

The YF-102A also provided a chance to finalise the aircraft's armament, with six guided missiles being fitted in the weapons bays for the first time. The bay doors incorporated tubes to launch 36 T-214-2 2-inch folding-fin aerial rockets (FFARs), replaced from May 1956 by 24 standard 2.75-in Mighty Mouse rockets, each weighing 19 lb and equating to a 75 mm artillery shell in terms of their explosive force. Each bay door had three launching tubes holding two four-foot-long rockets per tube. Aircraft

with the T-214-launching bay doors were re-fitted with Mighty Mouse doors. The firing sequence, from the opening of the bay doors to firing all 24 missiles and snapping the doors closed again, took barely two seconds. The pilot's armament selector gave him the option of firing six, 12 or all 24 rockets at once.

From 1957 the tubes in the inner doors for the left and right missile bays and in the two doors for the centre bay were removed, reducing the rocket complement to 12. F-102A 53-1793 was used at the Air Research and Development Command's Missile Development Center from January to March 1957 to fire the rockets at altitudes from 5000 ft to 53,500 ft and at speeds up to Mach 1.44. Rockets with pyrotechnic 'flash' heads, detonating at their tactical range of 1500 ft ahead of the fighter, were used for some tests. Delta Daggers retained FFAR capability throughout their careers and became the last USAF fighter interceptors to use this type of weapon. The FFAR remained in extensive use as a 'podded' store for tactical strike aircraft for employment against ground targets (and the occasional enemy MiG) in Vietnam.

If a pilot selected 'rockets' on his armament panel the six missile bay doors opened but the trapeze-type launchers for the AIM-4 Falcons remained in place. Many pilots had little faith in the FFARs' chances of hitting their target as they tended to scatter and sometimes collide ahead of the aircraft, but some were equally pessimistic about the Falcon in its early days. FFARs were normally used for rocketry practice, and most pilots had little opportunity to evaluate the Falcon as they rarely got to fire one. Although visits to Tyndall AFB, Florida, could provide the chance to launch at Ryan Q-2A Firebee drones over the Gulf of Mexico, a significant number of pilots never fired a guided missile during their F-102 tours.

Further intake revisions increased the maximum level speed to Mach 1.53 in January 1956. YF-102A 53-1791 was used to test a variety of intake types in an attempt to stop potentially destructive high-frequency vibration in the intake area at Mach 1.2 to Mach 1.3. An intake version with an extended ramp and stiffened inner walls was chosen, enabling a Mach 1.535 top speed, the fastest for any F-102.

In order to avoid the phenomenon that became known as inertia coupling, in which aircraft with long fuselages and relatively short wingspans could enter uncontrollable pitch and yaw movements during supersonic rolling manoeuvres, a taller vertical stabiliser, swept at 52 degrees, was added. Its height was increased by 33 inches, the trailing edge became vertical and its area was increased to 95 sq ft, the new tail causing a slight reduction in performance. Nevertheless, it was added to production aircraft from the 66th example after tests with the 23rd aircraft (53-1813).

The selection of the J57-P-23 engine and an overall Air Defense Command (ADC) Aircraft Gray paint scheme established the final production configuration in April 1957, although about half the production aircraft had already left the factory by then. Costly modifications continued until 1962 in order to re-manufacture most of the early examples to the final production standard, the Cook-Craigie plan having mistakenly assumed that the changes would have been

Undercarriage problems were quite common during the F-102 test phases, with the hydraulic pistons in the landing gear actuators often being to blame. With his aircraft possibly suffering from just such an issue, the pilot of F-102A-15-CO 53-1800 of the Air Research and Development Command chose to take the runway barrier (possibly at Edwards AFB). The jet's right main landing gear collapsed during the course of the landing. 53-1800 retains the small vertical stabiliser and early speed-brake configuration (*USAF*)

minimal and quite easily made. The 'Deuce' ('1-0-2', or 'one-zero-deuce' in card-player's language) finally reached USAF service standard in June 1956, although its wing camber was still not finally defined for the production line until October 1957.

Extensive tests in the summer of 1957 used Air Force Flight Test Center (AFFTC) aircraft 56-1000 with a Case X wing and 56-1317 with a revised wing in which the leading-edge camber was neutral at the wing root but increased gradually right out to the wingtip, rather than having a reflex up-turn at the tip. This new Case XX wing, with an accompanying increase in elevon area of 3 sq ft, was intended to improve low-speed handling, increase the service ceiling by ten per cent and give better climb performance and control in near-stall conditions. The improvements were quite subtle though, with pilot Lt Peter Fleischhacker commenting, 'I can't say I noticed the difference'.

A barrier arresting system was tested using a YF-102 and an arresting barrier cable at both ends of a runway. The aircraft ran into a safety net and this released a cable laying across the runway and attached to heavy ship's anchor chains. After the nose-wheel passed across it, a wire was supposed to rise up and trap the main undercarriage wheels, reducing the landing run to around 600 ft. In tests it was found that because of the F-102's length, the cable had risen and fallen back before the main wheels reached it. A barrier probe was installed in a fairing beneath the fuselage during later updates to production aircraft after arresting hooks had been added in 1960. When the drag 'chute handle was pulled the probe extended downwards and forwards to snag the wire and keep it raised above the runway. The arresting hook allowed the standard BAK-9 runway arresting cable to be used.

The braking parachute could be deployed just before touch-down, as former 152nd Fighter Interceptor Squadron (FIS) F-102A pilot Col Shaun Ryan explained;

'The plane was so docile that once you got used to it you could deploy the drag 'chute just before the wheels touched and it would not change the pitch of the aircraft. I never saw the value of this other than ensuring a slightly shorter landing roll, but we never had to use the entire length of the runway before turning off so why do things differently? The "Deuce" presented no surprises and it was very easy to land.'

T FOR TWO

The unfamiliar characteristics of the delta wing and the complexity of the F-102's weapons system resulted in a USAF request for a dual-control version as early as April 1952. It was required as a trainer that also retained operational capability, although the jet's revised fuselage contours would restrict it to subsonic speeds except in a shallow dive. The full MG-10 FCS could be installed, but this was not done in most cases and the type's combat capability was seldom called upon. In any case, maintenance crews generally had to devote their available time to working on the radar systems in the single-seat F-102As.

Although radar-equipped B-25 Mitchells, together with the standard T-33 trainer, had previously been used to prepare the first generation of fighter pilots for radar-equipped F-86Ds and F-94s, a purpose-built F-102 trainer was considered to be vital. Side-by-side seating, replicating the arrangement in a standard Link trainer simulator, made the instructor's task easier. It also echoed the design objectives of the Cessna T-37 trainer and two-seat versions of the Hawker Hunter and English Electric Lightning. Only the forward section of the basic YF-102A had to be redesigned for the two-man cockpit and revised air intakes, and the resulting fuselage was shorter at 63 ft 4 in. The whole section was made at Convair's Fort Worth, Texas, facility, as were the elevons, wing leading edges and other components for all F-102s. Area rule contouring was incorporated and the forward missile bay had to be deleted.

The first example (54-1351) was flown by Dick Johnson on 31 October 1955, and the early tests revealed significant buffeting around the cockpit area at high subsonic speed. Modifications to the bulbous canopy shape did little to improve the airflow, and the final solution proved to be rows of vortex generators around the forward canopy frame to prevent airflow separation. Initial orders in 1954 and early 1955 were for 48 examples, and a full order for 150 TF-102As was issued in December 1955 but delayed until the canopy problem was resolved.

TF-102A-45-CO 56-2376, from the final batch of 26 two-seaters, was assigned to the 482th TFS at Seymour Johnson AFB, North Carolina, in September 1962. Following its reassignment to the ANG, the aircraft continued to perform the training role with the 111th FIS of the Texas Air National Guard until October 1975, when it entered storage (*Terry Panopalis*)

Ejection seat tests were based on a mock-up of the TF-102A nose, accelerated along a track on a sled that could reach supersonic speeds when powered by 16 rocket propulsion bottles. Initially, the mock-up was fitted with one standard M-3 catapult-operated Weber seat and a second seat equipped with a rocket-powered 'RESCU Mark 1' unit.

TF-102A canopy problems continued in service. A 497th FIS aircraft was nearing its maximum speed on an orientation flight from its base at Torrejon, Spain, when half the windscreen shattered at 33,000 ft, almost precipitating an ejection. Another TF-102A (54-1364) from the 526th FIS at Ramstein AB, West Germany, lost its canopy completely in 1964, and the only replacement available had to be shipped from a squadron in Japan.

PUNCHING OUT

The Dash-1 pilot's manual gave ejection as the only feasible option in the event of engine failure. In that or a similar emergency, the usual limit on ejection was seen as 450 knots because above that speed serious injury would occur from wind-blast. The F-102 had a two-stage system. Its Weber ejection seat was designed for a pilot weighing 180 lb, and the combined weight of the seat and pilot was supposed to be under 500 lb.

To eject, the pilot adopted the correct position with heels against the front of the seat-base and elbows tucked in. He then raised one or both of the ejection handles, which jettisoned the canopy. Squeezing the ejection triggers detonated a quarter-pound charge at the base of the rocket tube to propel the seat up its support rails. The rocket motor ignited during the seat's last eight inches of travel and blasted it clear with 5000 lb of thrust. This provided a more gradual acceleration than the M-3, pushing the seat higher above the aircraft's tail on exit and making it less susceptible to an injury-inducing tumbling motion.

Within 0.3 seconds the forces built to 16 g, at which point the motor burned out and the shoulder straps and seatbelt automatically deployed the parachute at a pre-set altitude after the pilot had kicked himself free of the seat. Occasionally pilots forgot to perform that release movement, delaying the parachute's opening. Weber's solution was a 'butt snapper' canvas belt seat-man separator that ran from shoulder to knees and tightened forcibly, pushing the pilot out of the seat when his lap belt was automatically opened a second after leaving the aircraft. The modified seat became available in 1965.

The parachute automatically opened when the pilot reached 13,000 ft or less. If he was falling at terminal velocity (120 mph), the shock of the parachute opening was severe. The ejection seat's 'global survival kit' was in two fibreglass compartments in the base of the seat. One contained the pilot's emergency oxygen equipment, providing up to 15 minutes' supply for an ejected descent from high altitude, and the other had a full range of survival items in zip-up waterproof bags. A life raft was attached for flights that were likely to be over water, and it was suspended on a lanyard 25 ft below the descending pilot so that it and the survival pack made contact with the water or ground first, reducing the load on the parachute for the landing.

During production, both F-102As and TF-102As (from the 13th example onwards) progressively received a taller, Rheem-manufactured vertical tail

F-102A 54-1396 (with an original short vertical stabiliser) features the original red chequer markings of the 327th FIS 'Iron Mask' – the first operational F-102A squadron. It has the command stripes of Lt Col Charles E Rigney, who flew it from George AFB to Oklahoma City in September 1958, setting a new speed record in the process. To the right is one of the F-102A's direct predecessors, F-89H-1-NO 54-279. The H-model Scorpion had the same E-9 FCS as was fitted in early F-102s, as well as six GAR-1 and GAR-2 missiles like the Delta Dagger (*Terry Panopalis*)

to reduce the risk of roll-coupling. The Case XX wing was phased into the F-102A production line in June 1957, starting with 56-2336, but was not retro-fitted to former test aircraft. All 111 TF-102As had been delivered by mid-1958, the Case XX wing having been introduced to the two-seater line from the previous December.

In 1957, 46 earlier aircraft were returned from the various test programmes to be modified for squadron use. In an extensive re-manufacturing programme shared between Convair's Forth Worth and San Diego plants, with assistance from the San Antonio Air Materiel Area, the aircraft were stripped down, inspected and repaired. They were given the enlarged vertical fin, 137 inches tall and 95 sq ft in area rather than 68 sq ft, the small, original fin having been removed at Palmdale. Supporting framework for the enlarged version was bolted into place and then the structure was skinned over. Larger speed brakes and a braking parachute were added in April 1957 after it was found that the original, smaller brakes could sometimes open asymmetrically, causing severe instability or the induction of a downward pitch.

Early examples were given new radomes, updated MG-10 FCSs, a liquid oxygen system for the pilot, extended 'buzz fix' intake ramps and the ability to carry external fuel tanks. Two 215-gallon external fuel drop tanks could be fitted on underwing pylons, increasing endurance to two hours but restricting the aircraft to Mach 0.95. Smaller 192-gallon drop tanks were first tested on 27 December 1956.

In the same period the AFFTC used F-102A 54-1401 for an extended spin recovery programme. Although the aircraft was very resistant to spinning and recovered easily after two or three turns, with the control column at the neutral position, these characteristics had to be proven in extreme test conditions. A spin-recovery parachute was installed but seldom used, and provision was made for a jet-assisted take-off bottle under each wingtip to power the aircraft out of a spin, although this addition was never required in the tests.

F-102A 53-1813 was used to test the side-stick control column that was being developed for the F-106. It replaced the usual central, two-element control column with a smaller but similar unit on the right side of the cockpit. It was flight tested at Edwards AFB and favourably regarded by the test pilots, but never adopted. In 1956 F-102A 53-1802 performed vital cold weather tests in Alaska. It was cold-soaked to -30°F, exposed to Alaskan snowstorms and then launched on 16 flights, one of which reached Mach 1.5 and included successful rocket firing.

CHAPTER THREE

DEFINITIVE DAGGER

After numerous delays and reconfigurations, the F-102A was finally ready to enter squadron service in April 1956. For that Fiscal Year the USAF placed its first big Delta Dagger order comprising 562 F-102As and 150 TF-102A 'Tubs', although the order for two-seaters was reduced by 87 in July 1956. Another 140 F-102As were added in September 1955 and the final total for both variants was 1000 aircraft.

The jet's unusually long, eight-stage pre-service trials programme had involved up to 50 of the early aircraft, many of them temporarily labelled as JF-102As. Fourteen examples, including the long-serving 53-1787, were used by Convair and the AFFTC at Edwards AFB, seven flew from Holloman AFB, New Mexico, during weaponry trials and two others were with the Hughes Test Division at Culver City for FCS electronics development. The aircraft's SAGE development required another three at Hanscom AFB, Massachusetts, with the Cambridge Air Research Center. Finally, the Air Force Armament Center at Eglin AFB, Florida, used several aircraft from October 1955 for two years of MG-3 and MG-10 development work. Although half the production run had already been built, the final production configuration was not officially cleared until 2 April 1957 with F-102A-30-CO 54-1380.

The aircraft emerged from Convair's San Diego Plant 2 with a coat of primer (the only USAF fighters to be painted at that time) and were ground-tested, five at a time, at the company's Lindbergh Field facility.

The 86th FIS at Youngstown Municipal Airport, Ohio, converted to the F-102A in 1957 and flew the jet for three years before deactivation. The squadron only displayed token markings in the form of a small rudder flash, although 56-1103 borrowed a cartoon character for its missile-riding *MR. MAGOO II* nose-art in 1958 (*Terry Panopalis*)

The jets were then flown 140 miles to Palmdale, in Antelope Valley, where they were painted in Aircraft Gray and prepared for delivery to the USAF.

The Hughes MG-10 radar FCS also matured during the 1957 period and 300 earlier aircraft with less capable MG-3 systems were gradually returned to Convair's Palmdale facility to be upgraded to the new standard. Mainly, this involved the addition of AN/ARR-44 data link and MG-1 automatic flight control equipment. This equipment was housed (along with the AN/ARC-34 communications set) in large electronics racks in the nose and behind the cockpit.

MG-10 converted digital data to analogue for the pilot's cathode ray tube radar screen and it worked with the autopilot to fly the aircraft on an interception course. Some pilots considered its radar display to be more sensitive than the AN/APQ-109A radar set used in the F-4D Phantom II, although the latter had ground-attack modes as well. MG-10 locked the radar onto a target and tracked it while its linked computer calculated a collision-course flightpath, ideally crossing the target's track at an angle of 70 degrees. The pilot then selected appropriate missiles and began the firing sequence which would arm and prepare the weapons. At the correct moment the FCS opened the missile bay doors, extended the Falcons on their trapeze launchers and fired a salvo of three in rapid sequence.

In addition to calculating the fully automatic radar-lead collision course, the MG-10 also gave the pilot the option of manually-controlled interception using either the collision course (optical lead) or tail-chase (optical pure pursuit) method. The system provided a Falcon with full target information, and it also transmitted data such as the air density at the target's altitude to fine-tune the missile's directional controls. The development of this system posed such challenges in the 1950s that several aircraft had to be used just for MG-10 work, including a piston-engined Convair T-29 with a complete F-102 nose section constructed inside its fuselage.

The fixed IRST sensor ahead of the windscreen was added in 1963. Hughes had developed the system by 1960 for the cancelled F-108 fighter, although German scientists had in fact invented a basic IRST during World War 2. Similar IR devices were fitted to the F-106, F-101B/F and F-8E. The sensor had a horizontal shutter that admitted IR light and displayed it as a 'pip' signal on a B-scope radar screen. The radar could then be directed towards the source of the 'pip'. IRST could detect a B-47 at a distance of 35 miles from the bomber's rear. The unusual windscreen design (something of a Convair trademark) required a removable black vertical partition called a vision splitter situated parallel to its centreline to prevent internal reflections. The thin vertical bars on the windscreen side-panels were heating elements (*Terry Panopalis*)

When a very effective infra-red search and tracking (IRST) system was added from 1963 under Project *Big Eight*, its information was also fed into the MG-10 from a ball-shaped seeker head, cooled by liquid nitrogen and mounted in front of the windshield. The cooling was crucial, and once the liquid nitrogen ran out the system stopped working. As Col Mike Weppner recalled, 'After several modifications the IRST could be used in the "slaved mode", with its seeker head aligned with the longitudinal axis of the aircraft. When manoeuvring behind a target it could be slewed vertically with a thumb-wheel on the control stick.'

According to Weppner, when this system was carried over into

the F-106 in a retractable installation, 'the aircraft could be manoeuvring behind a target and the IRST was slewed until a tone was heard, then a switch action would result in a lock-on. This could be done "heads up" while staying visual on the target. The IRST search display was presented as a horizontal line across which the sensor signal moved back and forth. A "spike" indicated an infra-red hit and its position in azimuth was shown, but of course there was no indication of range.'

The fixed IRST sensor head had an 'irdome' seven inches in diameter and a multi-element telescopic lens made from silicon and sapphire with a lead selenide array to detect infra-red radiation of between three and six microns in wavelength. It could be used to cue the seeker heads of IR Falcon missiles to allow them to be launched when severe electronic jamming would defeat a radar-guided missile.

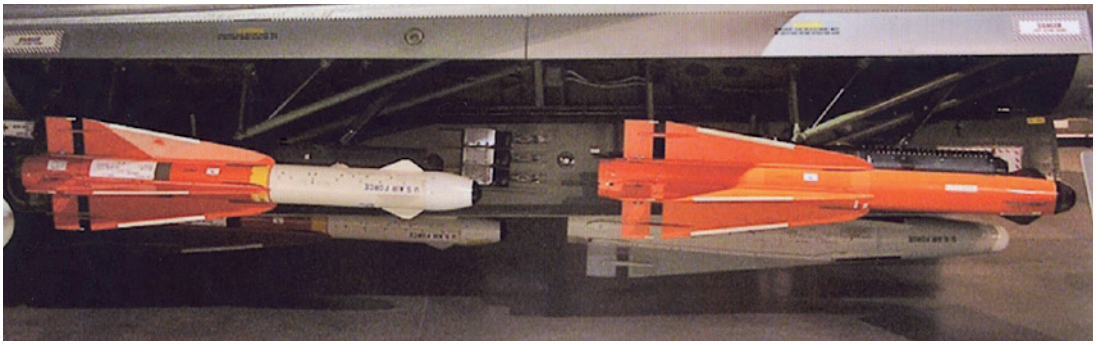
From 1965 the SAGE data-link was added to increase the MG-10's automatic interception capability – aircraft so modified boasted twin antennas beneath the rear fuselage. In the late 1950s some aircraft also had TACAN installed to work with ground stations. In all, the MG-10 weighed around 1700 lb. Some TF-102As had Hughes IRST systems and SAGE installed together with a modified MG-10T system whose data could be viewed on twin radar scopes in the cockpit. The SAGE link could always be overridden by the pilot, and there is little doubt that many would have done so in a real emergency as trust in the system, with its many problems, was often lacking. Former F-86D pilots found that the 'Deuce's' MG-10 operation and radar display were similar to the E-4 system that they had worked with, but the MG-10's larger antenna increased the E-4's detection range from around eight miles to 15 miles, with clearer reception.

FIGHTING FALCONS

Hughes' Falcon guided missiles began test flights in 1949 after three years of development. Testing had used up more than 400 missiles by 1952, and in that year the F-89H Scorpion became the first interceptor to field the weapon operationally. The Falcon was initially designed in 1947 as a subsonic, manually-guided, self-defence missile for bombers within the MX-798 project. In 1949 it was revised in project MX-904 as a supersonic free-flight weapon for fighters. In that role it could be fitted with either IR homing or semi-active radar guidance. By 1950, as the AAM-A-2 Falcon, it became a top-priority programme.

Long delta wings and a solid fuel T47 rocket motor blasted out 5560 lb of thrust, although only for 1.2 seconds. The radar-guided version was re-designated GAR-1 (Guided Aerial Rocket-1, later re-designated AIM-4) in 1955 and given a 4420 lb thrust Thiokol M9 motor that could accelerate the missile to Mach 2 before burning out after a mere 1.38 seconds. Although the weapon had a small 8 lb warhead containing only 2.7 lb of explosive, a direct hit by the 140 lb missile travelling faster than Mach 1 was sufficient to disable an aircraft.

The heat-seeking variant became the GAR-2, although Hughes determined that radar guidance was more reliable at that stage since IR homing devices were susceptible to distraction by chaff, flares, the sun or cloud. Radar-guided versions too could be diverted by electronic countermeasures (ECM), but



AIM-4D Falcons, which entered service in 1963, extend from the weapons bay of an F-102A. The light-coloured strips on the leading edges of the fins are contact fuses (*Terry Panopalis*)

it was thought that a combination of both missile types would increase the potential success rate. Both entered service in 1956, and they became the standard armament for the F-89 (carried in wingtip pods), together with the F-101B Voodoo and F-102, where they were carried internally. The first launch from a Delta Dagger took place in May 1955.

The Falcon was the earliest supersonic self-guided missile that could alter its direction without having to bank as it manoeuvred to intercept its prey, having accelerated to Mach 2.3. Development of the US Navy's AIM-9 Sidewinder equivalent heat-seeking missile also began in 1946, with a first test-firing in 1952, as did the US Navy-sponsored AAM-N-2 Sparrow semi-active radar missile. Both were far longer than the 6.5 ft-long Falcon, and would have a more successful operational record.

Guided missile armament for the F-102 was standardised as six Falcons, which could be either GAR-1 semi-active radar or GAR-2 IR homing weapons. The latter would generally be used for a pure pursuit attack as a 'fire and forget' missile, with an effective range of around five miles. Ideally, the missile would be fired up towards an enemy aircraft at higher altitude, thus placing the target against a clear sky background and eliminating the distractions of ground effect.

As the USAF's first operational air-to-air guided missile, the GAR-1 series evolved into the more manoeuvrable GAR-1D (AIM-4A from 1962 onwards, usually painted red-orange overall) and IR GAR-2A (AIM-4C, painted white and red-orange). Both were used extensively by the F-102. A succession of later versions included the IR AIM-4D, which was used with limited success by F-4D Phantom IIs in the Vietnam War – it also replaced the AIM-4C in F-102A- and F-101B-equipped units from 1963. Its seeker head was similar to the AIM-4F's, and it allowed a minimum launch distance of 1000 ft. The AIM-4D's principal disadvantage in combat over Vietnam was that its seeker head required a two-minute cooling time before launch to allow it to more accurately detect differences in heat radiation. There was also a lack of training on the missile for pilots who took it into combat aboard F-4Ds.

In the F-102A it was possible to shorten the preparation time for a manually controlled launch by selecting IR missiles, arming them and holding the trigger down for a few seconds. In a computer-controlled interception, the pilot selected the missiles, allowed the system to lock onto the target and then depressed the trigger at a point 20 seconds before firing, and held it down so that the MG-10 could manage the rest of the interception.

GAR-1D Falcons blast away from the weapons bay of F-102A-90-CO 57-0825 of the 329th FIS. This unit, which adorned its aircraft with a simple white chevron on a red tail-band, flew F-102s for little more than a year from 1958 before converting to the F-106A. 57-0825 was then passed to the 482nd FIS at Seymour Johnson AFB (*Terry Panopalis*)

A Falcon was designed to bring down a large, non-manoeuvring bomber with a direct hit which let the small warhead explode inside the aircraft. As an explosive device, the warhead was only slightly bigger than the 6 lb version fitted in each 2.75-in Mighty Mouse rocket, which also had a proximity airburst fusing option. Unlike the longer AIM-9 Sidewinder, a Falcon had no proximity fuse – a weight-saving measure, as was the small warhead. When used by the F-89H, pilots were advised to salvo their entire load of six externally-carried Falcons to increase the chances of a hit. Contact fuses were embedded in the leading edges of the missile's wings, requiring a direct hit to activate them.

GAR-1D was 78 inches long, with GAR-2 being 1.5 inches longer and 16 lb heavier than GAR-1D (which weighed 119 lb). Both versions were designed to reach Mach 3 during their short trajectory, with separate, larger elevons to give much better manoeuvrability at high altitudes. An improved version appeared in 1958 as the AIM-4F Super Falcon with a 28.7 lb warhead, longer range and improved guidance, but it was not used by F-102A units.

Also available was the Weapon System Evaluation Missile (WSEM or 'Wizzum'), a blue-painted inert body carried on one of the launchers to check out the aircraft's missile launching circuits. It recorded all the command signals to both the radar and IR missiles as traces on a four-inch wide roll of photo paper, including the angle of the radar antennas in the aircraft and missile, details of receiver synchronisation with the MG-10 system, electronic warm-up times and the amount of IR energy received by an IR missile's seeker head.

The new armament system required some rigid safety procedures for groundcrew. In 1958, a 37th FIS F-102A at Ethan Allen AFB, Vermont, was being given munitions checks by a technician who was mistakenly informed that the aircraft was not carrying missiles. The checks involved connecting the aeroplane to external power and setting the armament switches to the 'salvo' position. A crewman then reached into the nose-wheel well and pressed the 'flying switch' to activate all the aircraft's weapons systems. This switch was usually turned on only when the landing gear was retracted. As he did so, four missiles extended and fired. Three soared away and crashed into the ground but the fourth hit the nose landing gear, knocking the technician over and injuring him. At least his hand had been forced away from the 'flying switch' so that no more missiles could fire.

From 1957 ADC also had the Douglas AIR-2 (MB-1) Genie, an unguided air-to-air rocket with a nuclear warhead and a six-mile range, for use against large bomber targets or formations. It was issued to squadrons flying the F-89 and F-101B. Convair proposed a weapons bay modification to the F-102A to allow two to be carried, 53-1797 being converted and then used to conduct a successful Genie launch at Holloman AFB in September 1957 at Mach 1.1 and 50,000 ft. The programme was cancelled later that same year, however, partly because changes to the missile bay would cause further delays in delivery of F-102As.

Instead, the missile was specified, together with Falcons, for the 'F-102B' project, which became the F-106 'Ultimate Interceptor'. It was also issued to F-89J units, where the weapon was utilised under the strictest security. Col Mike Weppner remembered a somewhat unorthodox tactic for launching the MB-1;

'At one time, the procedure for a low-altitude stern attack with the nuclear rocket included continuing straight ahead after launch until we hit the shock wave, at which point we initiated a break-away manoeuvre. I think most pilots decided that probably wasn't going to happen!'

An F-89J made the first successful MB-1 test firing on 19 July 1957. The nuclear warhead was detonated from the ground and an Illinois ANG F-84F was flown into the mushroom cloud 40 minutes later to gather test samples.

A nuclear-tipped Falcon in the form of the GAR-11 (AIM-26A) 'Nuclear Falcon' was also developed, the weapon being part of the arsenal of 450 F-102As for more than ten years from December 1961. Introduced in 1958, the missile had a similar range to the GAR-1/2 but it was fatter, 85 lb heavier and its length was increased to 84 inches, requiring adaptation of the trapeze launchers in the F-102A's central missile bay to accommodate two AIM-26As and the installation of modified bay doors with half the complement of FFAR tubes. A new Thiokol M60 solid-fuel rocket motor, burning for 2.09 seconds, accelerated it to Mach 2.

Unlike the Genie, the GAR-11 used radar-operated proximity fuses and semi-active radar homing to guide it head-on at an approaching bomber. Hughes produced the GAR-11A (AIM-26B) version with a conventional warhead for training purposes and to remove the risk of carrying nuclear material over friendly territory.

The Mk 54 0.5 kiloton nuclear warhead, although much less powerful than the Genie's 1.5 kiloton W25 with its 1000-ft lethal radius, obviously offered far greater certainty of a kill than the small conventional warheads in a situation where nuclear bombers had to be stopped at all costs. It was proximity fused so that it would detonate near a bomber and the resulting neutron radiation from the explosion would then disable the aircraft's own nuclear weapon, rather than allowing the bomb to detonate when the bomber crashed into the ground. The warhead in the MB-1 Genie had the same basic purpose in minimising the amount of nuclear radiation that would be experienced at ground level.

(*text continues on page 44)*

An AIM-26B Falcon extends from the forward missile bay of this F-102A, with an AIM-4D behind it. Six 2.75-in free-flight rockets are loaded into the tubes within the bay doors, and each missile has a silver firing circuit control box attached to the face of the door (*Author's collection*)

COLOUR PLATES

1
F-102A-45-CO 55-3402 of the 327th FIS/64th AD, George AFB, California, 1958

2
F-102A-41-CO 55-3368 of the 16th FIS/51st FIW, Naha AB, Okinawa, 1960

3
F-102A-45-CO 55-3392 ***ROAD Runner II Beep Beep*** of the 40th FIS/41st AD, Yokota AB, Japan, 1961

4
F-102A-70-CO 56-1294 of the 317th FIS/5070th ADW, Elmendorf AFB, Alaska, 1960

5
F-102A-55-CO 56-1006 of the 431st FIS/86th AD, Zaragoza AB, Spain, April 1962

6
F-102A-51-CO 56-0960 ***RED-STRIPED RASCAL*** of the 4th FIS/39th AD, Naha AB, Okinawa, 1960

7
F-102A-55-CO 56-1032 of the 32nd FIS/86th FIW, Camp New Amsterdam, Soesterberg AB, the Netherlands, 1961

8
F-102A-95-CO 57-0907 of the 460th FIS/337th FG, Portland International Airport, Oregon, September 1962

9
F-102A-60-CO 56-1009 of the 48th FIS/Washington Air Defense Sector, Langley AFB, Virginia, May 1960

10
F-102A-70-CO 56-1237 of the 526th FIS/86th AD, Ramstein AB, West Germany, 1962

11
F-102A-60-CO 56-1060 of the 525th FIS/86th AD, Bitburg AB, West Germany, 1961

12
F-102A-60-CO 56-1080 of the 496th FIS/86th FIW, Hahn AB, West Germany, 1964

13
TF-102A-35-CO 55-4045 of the 64th FIS/325th FW, McChord AFB, Washington, 1957

14
F-102A-95-CO 57-0870 of the 57th FIS/Air Forces Iceland, Keflavik AB, Iceland, 1972

15
F-102A-65-CO 56-1208 of the 102nd FIS/106th FG, New York ANG, Suffolk County Airport, Westhampton Beach, New York, September 1974

16
F-102A-65-CO 56-1157 of the 509th FIS/405th FW, Don Muang Airport, Bangkok, Thailand, 1962

17
F-102A-41-CO 55-3366 *'Sly Mongoose'* of the 199th FIS/154th FIG, Hawaii ANG, Hickam AFB, Hawaii, 1971

18
F-102A-45-CO 55-3419 of the 118th FIS/103rd FG, Connecticut ANG, Bradley Field, Windsor Locks near Hartford, Connecticut, 1970

19
F-102A-80-CO 56-1448 of the 182nd FIS/149th FIG, Texas ANG, Kelly AFB, Texas, 1961

20
F-102A-90-CO 57-0806 of the 196th FIS/163rd FIG, California ANG, Ontario International Airport, California, 1972

21
F-102A-15-CO 53-1802 of the 190th FIS/124th FG (Air Defense), Idaho ANG, Boise Air Terminal, Idaho, 1971

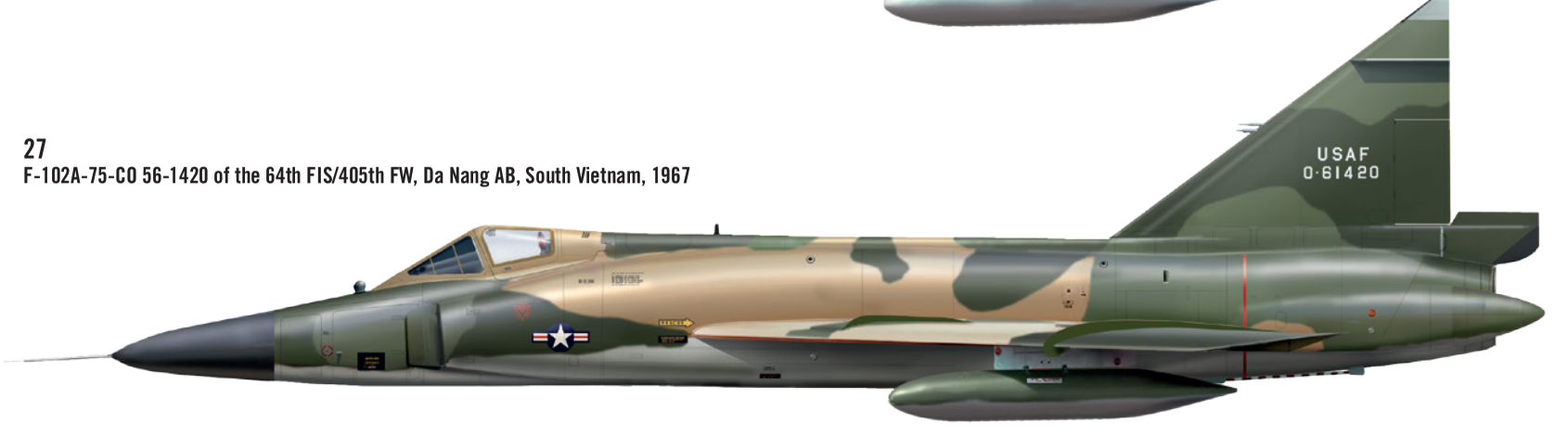
22
TF-102A-45-CO 56-2372 of the 178th FIS/119th FIG, North Dakota ANG, Hector Field, Fargo Municipal Airport, 1967

23
F-102A-55-CO 56-0981 of the 152nd FIS/162nd FIG, Arizona ANG, Tucson International Airport, Arizona, March 1969

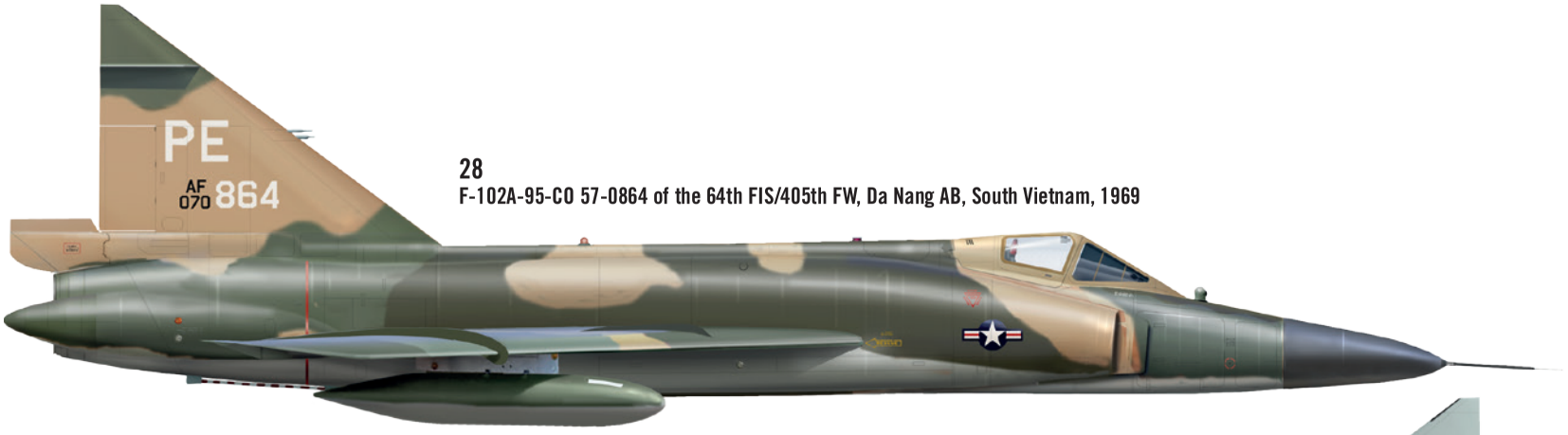
24
F-102A-90-CO 57-0855 of the 134th FIS/158th FIG, Vermont ANG, Burlington International Airport, Vermont, 1970

25
F-102A-90-CO 57-0847 of the 146th FIS/112th FIG, Pennsylvania ANG, Greater Pittsburgh (Coreopolis) Airport, Pennsylvania, 1973

26
F-102A-90-CO 57-0823 of the 116th FIS/141st FG, Washington ANG, Geiger Field, Washington, 1967



27
F-102A-75-CO 56-1420 of the 64th FIS/405th FW, Da Nang AB, South Vietnam, 1967



28
F-102A-95-CO 57-0864 of the 64th FIS/405th FW, Da Nang AB, South Vietnam, 1969

29
F-102A-45-CO 55-3389 of the 144th *Filo*, *Türk Hava Kuvvetleri*, Murted AB, Turkey, 1970

30
TF-102A-40-CO 56-2327 of the 114th *Pterix*, *Elliniki Polemiki Aeroporia*, Tanagra AB, Greece, 1974

An AIM-26B's 48.5-lb continuous rod warhead, detonated by the proximity fuses, could project lethal shrapnel over a 60-ft radius, making it a powerful weapon that remained in use throughout the F-102's years of service. About half of the production Delta Daggers were modified to allow them to carry the AIM-26B, or a mixture of AIM-26Bs and AIM-4s, in their central bays. In 1961, during a period of political tension in Europe, the F-102s of six ANG squadrons were also adapted to carry AIM-26As.

Testing of the GAR-11 was completed over three years from August 1959. The GAR-1/MG-10 system had been thoroughly worked out in a number of F-102s at Holloman AFB since September 1954 when the first GAR-1 was fired. FFAR firing tests began in November 1954, and in July 1955 a YF-102A demonstrated its full armament punch when it expended all six Falcons and 24 FFARs in a spectacular ten-second salvo. The firing sequence for a full load of FFARs was little more than two seconds.

Firing tests against drone targets took place at Holloman AFB, where a war-surplus QB-17 bomber was shot down on 5 June 1956. Surplus Martin MGM-13 Mace and MGM-1 Matador cruise missiles were also used as simulated bomber targets at the White Sands Missile Range in New Mexico. In a March 1957 night launch at Mach 1.1 using GAR-2 missiles, two Matadors were destroyed. They represented bombers on predictable flightpaths that would allow an interceptor pilot to use all of the 16 seconds he needed to release his missile after the initial radar lock-on.

Both types of Falcon were disadvantaged by their location beneath the aircraft, which could mask the target from their seeker heads if they approached it at an angle where the carrier aircraft was between the target and the missiles. Col Weppner experienced these problems as first hand;

'While at Tyndall AFB I was fortunate to fly missions that involved missile shots. The AIM-4F [radar guided] and AIM-4G (IR) were "hit-to-kill" missiles and not terribly effective in a manoeuvring engagement. While flying as safety chase pilot during William Tell weapons competitions or the Weapons Systems Evaluation Program [WSEP], I watched several manoeuvring engagements against drones in which the missiles, due to their location in the belly of the jet, were "blind" because the shooter was flying a lag pursuit attack [one in which a fighter follows a target aircraft but flies outside the target's turn radius and remains in its blind spot, but cannot bring its weapons to bear on the target]. For most interceptor pilots, launching missiles during WSEP was the first time they had ever expended such weaponry.'

For pilots managing the F-102A's service entry, the Hughes MG-10 offered them a versatile system that provided options ranging from full manual control to a virtually automatic interception with minimal pilot input. Of the MG-10's three modes, the Attack option used computer inputs to feed directly into the hydraulic circuits that operated the rudder and elevons to steer the aircraft. Ground control directed the jet to an offset point, and from there it was steered onto a collision course until it picked up the target on its own radar. On the pilot's

radar scope 'B' display, a 'time to go' circle appeared two minutes before he advanced into the correct range for a missile launch, and it would shrink in diameter as he closed in. The target's range was indicated by the distance of a target blip from the bottom of his radar screen, and its heading was shown by the lateral position of a steering dot on the screen. A separate gauge on the instrument panel showed the target's altitude.

When the radar locked on to the target it supplied the computer with its range, angular position and closure rate. It then computed steering instructions and missile firing signals, sending them to the missile auxiliaries to warm up the weapons and line up the GAR-1s' radar heads with the aircraft's main radar, prior to firing them at the correct moment. In early tests it was found that the blast from the Falcon's rocket motor could cause missiles to break their radar lock as soon as they were fired.

In a second mode, known as Pilot Assist, the system kept the aircraft moving on a set course or bank angle according to the control settings established in the cockpit without further direct input from the pilot. He could negate that mode merely by moving the control column. A third AILAS (Automatic Instrument Landing Approach System) mode worked with instrument landing system signals from the ground to manage automatic landings at night or in bad visibility. The radar could also be switched to 'snake' mode when flying in poor visibility, the jet then being locked on to an aircraft flying ahead so that the pilot could follow it. There was also a ground-mapping mode, and in 1970 most surviving F-102s were fitted with AN/ARN-21 TACAN sets.

ADC ENTRY

By June 1956, when the F-102A was ready for issuing to ADC squadrons, its overall weight had increased by 5000 lb above the original 1951 specification. The Delta Dagger was a substantially larger aircraft than had originally been envisaged, and this in turn meant the fighter would never reach its speed objective of Mach 1.88 with a J57 engine. However, three years of extensive flight testing had given ADC an effective replacement for its F-86D, F-94C and F-89 interceptors, all of which were obsolescent after only four years of service, and the 'Deuce' became the command's first – and only – dedicated supersonic, all-weather interceptor. Of its predecessors, the F-94C had a good reputation for low-altitude interception, while its rocket-firing installation was more reliable than similar armament in the F-89 and F-86D. The first 'all-rocket' fighter, it pioneered the collision course interception techniques that would be developed by later types.

The re-activation of ADC as a principal USAF command in 1951 in response to the outbreak of fighting in Korea the previous year prompted urgent re-equipment with more capable interceptors than the F-80s and F-84s that had equipped ADC's predecessor, Continental Air Command, in the late 1940s and its early F-89 and F-94 versions that had arrived in 1950.

The first service F-102As to leave Convair's Plant 2 at San Diego went to the 327th FIS at George AFB, California, in April 1956,

replacing F-86D 'Sabre Dogs'. ADC celebrated the arrival of its 'First Supersonic Squadron' with a public air pageant of fighters from World War 1 biplanes onwards, a demonstration sonic boom to amuse the guests and a mass take-off by 12 short-tailed, MG-3-equipped F-102As. Re-equipment of the 11th FIS at Duluth, Minnesota, followed, while the 2nd and 5th FISs within the 52nd Fighter Group (FG) at Suffolk County AFB, New York, transitioned to F-102As in March 1957. By the end of that year there were 428 'Deuces' in service with ADC, and by December 1958 27 squadrons were flying 651 F-102s. Although the last F-102A (57-0909) left the production line in September 1958, ADC units equipped with Delta Daggers continued to form well into 1962. By then, however, F-101Bs and F-106s were beginning to replace F-102s in some units.

'Deuce' squadrons were initially concentrated in bases corresponding to the northern limits of the Arctic air defence area and around the heavily populated cities of the northeastern USA. Assignment to ADC usually meant cold weather locations for the crews. In the summer of 1958 the 327th FIS became the first F-102 unit to be based outside the USA when it moved to Thule AB, Greenland. By then it had tall-tail F-102As and new International Orange arctic markings in place of its distinctive red lightning bolts on white tails.

Life at Thule was challenging. Most of the base's buildings were heavily insulated metal structures balanced on stilts that were sunk into the permafrost. Winds of 100 mph were common, and there were no emergency diversion fields other than a belly landing on the ice-cap. Pilots were always aware that their base was the closest to the USSR, and their alert status during the Cuban Missile Crisis kept the majority of pilots of Thule's 327th and 332nd FISs on alert status in their flight suits most of the time.

Some of the armament problems experienced with the previous F-89 and F-86D fighters persisted. Handling the Scorpion's rockets could be a risky business for groundcrew. On one occasion a technician plugged a grounding lead into the right pod of a 2nd FIS F-89 on the flightline, and when he then switched on the power all 52 rockets fired off, slewing the aircraft around by 45 degrees and bombarding the grounds of the US Army compound next door. When the unit's F-102s arrived, another electrical fault caused a Falcon to fire from one of them while the pilot was checking his fuel pumps with the aircraft inside a hangar. Theoretically, the many safety procedures in place made this impossible, but the end result was a burned-out F-102A and a wrecked hangar. Fortunately, there were no injuries in either case, despite the 'Deuce's' entire load of Falcons and 2.75-in rockets exploding.

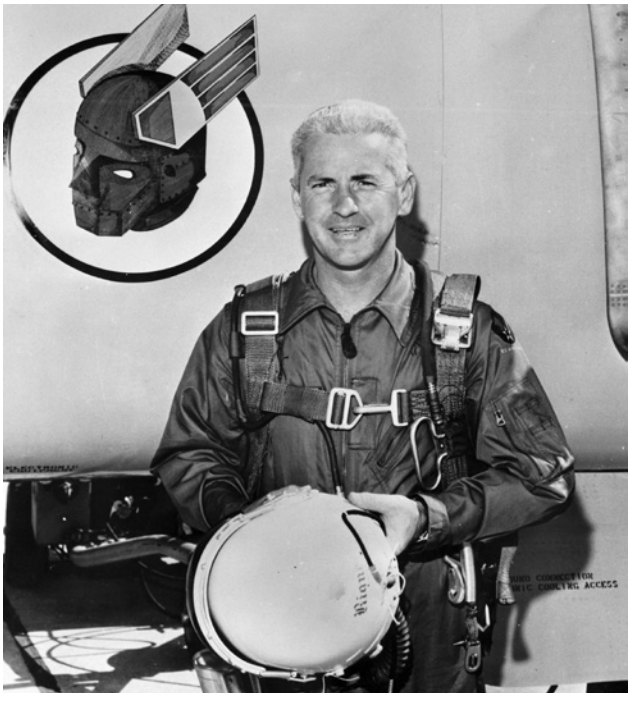
OPPOSITE
Lt Col Charles Rigney was the CO of the USAF's first Delta Dagger squadron, the 327th FIS. A veteran of combat in World War 2 and Korea (and, later, Vietnam), he garnered positive publicity for the new fighter when he flew F-102A 54-1396 on a 1120-mile flight from George AFB to Oklahoma City at a record average speed of 819.5 mph. Rigney also led a team of pilots from the 327th FIS that participated in the Bendix Trophy race of 1957 (*USAF*)

PILOT PREPPING

This massive F-102 training and transition programme had inevitable effects on readiness and efficiency in ADC squadrons as they practiced making high-altitude interceptions with such sophisticated equipment and missiles, whose early reputation for unreliability was widespread.

Transition for the pilots began with conversion training of experienced ADC aviators by Convair, who provided ground-school education and

OPPOSITE
World War 2 ace Capt Kenneth Chandler of the 11th FIS, winner of the 1957 Bendix Trophy transcontinental race with an average speed of 679.05 mph and a record time of 54 minutes 45.5 seconds for the 619.73 miles flight from O'Hare Airport, Chicago, to Andrews AFB, Washington, D.C., in F-102A-65-CO 56-1196. Six aircraft from the 11th FIS took part in the race. Chandler and fellow ace Capt Chuck Yeager had provided the F-86 combat flying sequences (shot in 1956) for the Howard Hughes film *Jet Pilot*, starring John Wayne (*USAF*)



check-flights. In the late 1950s there were still numerous USAF pilots without any jet experience, including a number of senior officers who were about to take charge of jet fighter squadrons. Project *Blue Flame* was instigated to qualify them. The pilots then took their aircraft and new knowledge back to their squadrons, where others could learn to fly the 'Deuce' with the aid of an MD-3 simulator and the two TF-102As allocated to each unit.

The USAF gave its new aircraft a customary headline-making demonstration for its introduction when the CO of the 327th FIS, Lt Col Charles E Rigney, took F-102A 54-1396 on a 1120-mile flight from George AFB to Oklahoma City, Oklahoma, at a record average speed of 819.5 mph. Rigney described the 'Deuce' as 'the easiest plane to fly that I have ever been in', and it quickly gained a reputation as the only fighter that could intercept a B-52 at its maximum altitude.

Six F-102s from three ADC squadrons, including the 327th FIS, subsequently took part in the 1957 Bendix Race, a 615-mile course between Chicago and Washington, D.C., that had been flown at an average speed of 666 mph by Maj Manuel Fernandez's F-100C Super Sabre the previous year. Capt Kenneth Chandler of the 11th FIS completed the course in a record 54 minutes and 45.5 seconds, averaging 679.05 mph. His commanding officer, Col Robert L Gould, took second place, and two minutes after Chandler, the sixth and last aircraft in the record-setting group landed. Chandler had pushed his F-102 so hard that it ran out of fuel as he taxied in at Andrews AFB. F-102 units also won the Hughes Achievement Award for interceptor squadrons on eight occasions between 1956 and 1970.

From May 1960 pilot training was managed by the 3555th Flying Training Wing (FTW) of Air Training Command (ATC) at Perrin AFB, near Sherman, Texas, which was taken over by ADC in 1962. Training was then managed there by the 4780th Air Defense Wing (ADW) of the 73rd Air Division (AD). That wing, headquartered

at Tyndall AFB, also controlled the Interceptor Weapons School. Perrin had previously trained interceptor pilots for the F-86D, and it took over F-102A indoctrination to replace the somewhat haphazard training processes that had previously been partly the responsibility of individual F-102 squadrons. 4780th was the only 'Deuce' replacement pilot training unit in ADC, and its task required a large fleet of F-102As and TF-102As.

The 4780th was soon training 120 F-102 pilots per year, and the unit's role expanded to give aviators assigned to other non-delta-wing aircraft some experience of the wing's unique characteristics. These included a high angle-of-attack on landing that restricted the pilot's forward view. As Col Mike Weppner found, 'The swept wing made for significant adverse yaw, but early in training the use of rudder during high angle-of-attack manoeuvring became second nature.' Later, pilots for the B-58A supersonic bomber flew in the TF-102A at Perrin before beginning their specific Hustler courses. In 1962 the F-102As of the 326th FIS 'Sky Wolves' took on B-58As of the 43rd Bombardment Wing in interceptor trials – a real test for F-102As against much faster bombers.

Perrin's 'Deuce' training continued until July 1971, and the base closed the following year. The 4780th included the ADC's 4781st Combat Crew Training Squadron (CCTS), which took over training duties from ATC's 3555th FTS/355th FTW in July 1962. In 1969 the unit's Director of Operations was the colourful Korea and Vietnam veteran Col Howard 'Scrappy' Johnson, who had won the Collier Trophy in 1958 for a record flight to 91,249 ft in an F-104A interceptor. At Perrin he encouraged intense competitiveness, aided by the instructor pilots, many of whom also had long track records of fighter experience. In Johnson's case that amounted to squadron service on 15 types of fighter. The wing had a very good safety record, one of its few losses occurring on 7 July 1965 when F-102A 56-1492 was inadvertently shot down by an F-106A Delta Dart on an armament practice sortie from Tyndall AFB!

Lt Col Peter Fleischhacker went through the Perrin course, although he was later assigned to an ADC F-101B unit, flying a two-seat interceptor that was originally designed as a long-range escort fighter for Strategic Air Command (SAC) but was redesigned for the interceptor role and accepted in 1955 as a back-up when the F-102 programme appeared to be in trouble;

'The Perrin syllabus started with an advanced instrument course of 25 hours in the back seat of a T-33 under the hood, then 55 hours in the two-seat "Deuce" to learn interception techniques and maybe some compassion and appreciation for the poor bastards who were going to sit in the back seats of our Voodoos. As a brand new 1st Lieutenant, I scared a whole bunch of senior captains and majors who had to ride with me, but not a single Russian bomber got through the DEW [Distant Early Warning] line on my watch!

'It is said that a fighter pilot will never forget the first fighter that he loses his virginity to. So, the "Deuce" is my girl. I found her a dream to fly, stable and forgiving. On a two-ship approach one could trim her up with the flight lead's wingtip on the [insignia] star and she would stay there with almost no control inputs. On an intercept you could concentrate on the [radar] scope and not worry much about where the jet was going. I was to learn later, when

The pilot of immaculate, but undecorated, 498th FIS F-102A 56-1133 wears a David Clark MC-3 partial pressure suit (with an MA-2 full pressure helmet) and holds the tools of his trade in December 1956 – an early AIM-4A missile and an FFAR with its fins safely folded. The forward section of the 20-inch-long extended intake ramp overlapped the large upwards-opening door of the main electronics bay for the five units of the FCS (seen here). That part of the ramp therefore had to be built into the door (*Terry Panopalis*)

I flew the Mirage III on an exchange assignment, that this is a characteristic of a well-designed delta wing.'

Col Weppner recalled that one of the F-102's novelties was its 'two-handled stick. The right side was basically like any other fighter stick. The left side was used to control the radar and the infra-red tracking'. Lt Col Fleischhacker also found no problem with the two-section control column but, 'sweet as she was, the "Deuce" was not without some vices. That J57 was prone to compressor stalls, usually when you needed some power the most. We saw that again in the F-100 [also with the J57], but oddly the F-101, sporting two J57s, never ever had compressor stalls. The "Deuce" also had a problem with the power setting at 86 per cent that set up some kind of vibration harmonic in the accessory drive shaft that had to be avoided, lest the shaft would shear and stop the motor.

'The cockpit lacked any kind of aural warning, so if you had your head in the scope it was easy to miss a warning light – I failed to spot a "canopy unlocked" light one time in the middle of an interception. The canopy had a pneumatic cinch-down feature that apparently worked very well because I made it home at slow speed with the cockpit pressurisation off and the canopy stayed put. The canopy light automatically squawked "Emergency" [by radio], so I was the only one unaware of my problem.

'Speaking of the cockpit, that was quite a piece of work. First, the angular windshields caused reflections that made it hard to see out to the front. This had to be remedied with a vertical panel down the middle, causing a lot of head movement by the pilot on finals [to landing]. The canopy itself featured an I-beam directly above the pilot's head that meant you could not eject through the canopy if the need ever arose. Then they built the TF-102A "Tub", a side-by-side trainer that thoughtfully featured an I-beam above each seat. You can't make this up!'

A similar canopy beam was used in the F-106, and, as Col Weppner explained, 'When we began doing ACM [air combat manoeuvring] in the F-106 it became a serious vision blocker. Later, when we got the gun capability [an M61 rotary cannon in the F-106's belly], the canopy was replaced with an acrylic bubble canopy for better visibility. When I began in the F-106 the radar scope was viewed through a cone-like hood. Later, we got a daylight scope that negated the need for the hood.' The

"Deuce" never had any of these updates, and its ACM capability, which many pilots rated, was never required for its designated operations.

The F-106 also introduced a more sophisticated information display for the pilot. 'Below the centre console and in front of the stick was a Tactical Information Display,' Col Weppner recalled. 'When everything was working it would show the aircraft's position and the target location on a map display. To view it, the pilot pretty much had to lean forward and down. Try that at night, while manoeuvring, and imagine the resulting vertigo!'

Lt Col Fleischhacker also found that, in the F-102, 'The oxygen system, with 100 per cent oxygen at full pressure, took some getting used to, and one could always tell the "newbies" on the radio, trying to talk against the pressure.' After moving to the Voodoo, he was able to compare the two contemporary fighters. 'The F-101 was definitely the better interceptor in the Cold War environment. It had more speed, more range, more radar and more armament. However, the Voodoo was neither stable nor forgiving. In fact, like the F-100, it was a real handful. But no compressor stalls.' The F-102's greater manoeuvrability was no real advantage either. 'Interceptions were typically from the front quarter or beam, with a stern conversion if you missed. It was all at high speed, with little or no turning – not a dogfight environment.'

Col Weppner, who went on to fly the F-106, also enjoyed the F-102's stability when formation flying, and thought the 'Deuce' was 'a great lead-in to the F-106. The [F-106's] J75 was a terrific engine. The F-106 was much faster and more powerful. My first impression of the F-102 was that it was big compared to a Northrop T-38. I had difficulty with close formation in the T-38 but found it easy in the "Deuce". Perhaps the most significant factor was that flying had to become almost automatic, as I had to deal with the complexities of a weapons system.' In respect to the course syllabus taught at Perrin, he noted, 'We learned interception procedures, attack geometry, air-to-air radar and (as I recall) infra-red search and track, together with direction from intercept controllers. One of the most interesting was the rocket attack in which the target was approached from about a 100 degrees aspect.'

Between 1958 and 1966 Portland International Airport, Oregon, resounded to the thunder of the 460th FIS's Delta Daggers, with their distinctive black and yellow wingtips and large *CAVE TIGRIM* tail insignia. The aircraft's Delta Dagger name was not adopted until it had entered service with its first operational squadron, the 327th FIS, in mid-1956. This F-102A-95-CO was later operated by NASA and three ANG units prior to being converted into PQM-102B drone '839' in 1981 (*Terry Panopalis*)

CHAPTER FOUR

CAGING THE 'BEAR'

The 317th FIS was the first F-102 squadron to be assigned to Alaskan Air Command, its aircraft arriving at Elmendorf AFB from 1 September 1957, followed two weeks later by the 31st FIS. After experiments with International Orange 'arctic' paintwork on the vertical tail, outer wings, elevons and lower rear fuselage, the paint was applied to the wingtips and tail. Some aircraft also had their rear fuselages, rudders and spines painted too, and the 317th FIS added lightning flashes to its drop tanks. The unit's F-102 operations, including many interceptions of Soviet aircraft, continued until 1969 – the year in which this F-102A-75-CO was destroyed in a non-fatal mid-air collision over central Alaska (on 13 June) with a 21st Composite Wing EB-57E electronic reconnaissance aircraft (*USAF*)

Re-equipment of ADC squadrons near the northern borders of the USA continued through 1957. The 27th FIS – the oldest US fighter squadron – traded its two-seat F-94Cs for F-102s at Griffiss AFB, New York, from June 1957, operating from here alongside the F-89s of the 465th FIS. Capts Herman Jenkins and Frank Keller delivered its first TF-102A 'two-holer' on 9 June after a window-rattling afterburner pass beside the Operations building to conclude a 400-mile flight from Wurtsmith AFB, Michigan. Their conversion training began with 20 hours in the simulator and two flights in a 'Tub', followed by the first single-seat F-102A sortie. The squadron's new black-and-yellow chequerboard and chevron markings with a black star and falcon were designed by Chris Clark and inspired by the chrome trim on a 1957 DeSoto automobile. The 27th's F-94 back-seat Radar Observers (ROs) were re-assigned to other units or left the USAF.

Pilots were immediately impressed by the 'Deuce's' power and ease of handling, although some were caught out by its aerodynamic smoothness compared with the straight-winged Starfire that the F-102 replaced – pilots had to learn to use their speed brakes more than usual. Unreliable avionics, including radio beacons, TACAN and radios, were a feature of the introductory phase for the aircraft, while taller pilots found that they had to sit with their heads tilted slightly downwards due to the v-shaped canopy, causing aching necks after a long flight. Others, used to day fighter

assignments where they had relied on their own eagle eyes to spot their prey, found relying on a hooded radar an unnatural skill to master. Wearing the clumsy pressure suits for which pilots were fitted if they were likely to fly above 50,000 ft, as most Alaskan Air Command pilots were, made the experience even less comfortable. Indeed, the suits could put some cockpit controls, including the temperature control, out of reach.

There were new adaptations on the ground also. The standard alert hangars were too small for F-102s, which necessitated the fitment of triangular extensions to their doors so that the 'Deuce's' pitot booms could be accommodated. Furthermore, additions to the rear doors were required for the taller vertical tails. In 1958 new two-aeroplane shelters were built that allowed pilots to taxi in and close the doors to avoid the snow that would often be falling outside. Missiles and fluids in the aircraft also needed covering, as they could not be allowed to freeze. However, Alaskan Air Command's units (the 31st and 317th FISs, transferred from ADC in 1957) had to make do with 'nose hangars' that just covered the front half of the aircraft to allow missile loading and work on the avionics and cockpit.

The hazards of flying in the arctic environment were emphasised by the loss of 31st FIS F-102As 56-1275 and 52-1276 near Galena, Alaska, in May and January 1962, respectively, and, in particularly tragic circumstances, the disappearance of 332nd FIS F-102A 57-0873 on 14 December that same year. The aircraft was lost while being flown by the squadron's operations officer, Maj Robert Daum, on a functional test flight from Thule. Two other aircraft and two crew were killed in the search for him, and no trace was ever found of the pilot or his fighter.

There were also delays in delivering technical manuals, power units and towing tractors to the 27th FIS's groundcrew, while pilots often turned to their Scorpion-flying colleagues for advice on the F-102's radar systems. Matters were not helped by the introduction of consolidated air maintenance squadrons based on SAC methods. Instead of working within separate squadrons, maintenance was arranged on a base-wide system across all units, with consequent loss of competitiveness and morale. At Griffiss this meant that enlisted men had to work on three different types of fighter including the F-102A.

Taxiing out over Thule AB's snow-covered terrain was all in a day's work for the 332nd FIS in 1961 after being transferred from the appreciably warmer environment of England AFB, Louisiana, in 1959. The unit had previously operated from McGuire AFB, New Jersey, as one of the first F-102 units in 1957. Taxiing the F-102 was an acquired art as the pilot could not see his wingtips and forward visibility through the windscreen was restricted (*Terry Panopalis*)

At the same time the establishment of the radar warning DEW line and the formation of the North American ADC, incorporating nine Royal Canadian Air Force CF-100 Canuck squadrons as well as USAF units, in 1957 put increasing pressure on the new F-102 units to reach high levels of proficiency. The growing numbers of Tupolev Tu-16 bombers in use by the USSR was a particular source of concern. 'Deuce' pilots' interception skills could be refined by some unofficial one-on-one practice with another F-102, but ad hoc ACM practice was not allowed. It was in any case restricted by the aircraft's 6.5 g limits, and by the need to accelerate to around 500 knots to encourage the 'Deuce' into a loop manoeuvre.

Bases like Griffiss were expanded and modernised as part of the new response to an increased Soviet bomber threat. The 27th FIS also sustained its first F-102A casualty in 1957 when 1Lt Hugh Fuller landed a quarter-mile short and skidded through the mud of a runway construction area, removing his undercarriage and starting an engine fire. He emerged unharmed and walked away. Because of the delta wing's gradual stall characteristics, pilots would sometimes be unaware of a rapid sink rate on final approach and find themselves unable to pull up in time to reach the end of the runway. Carefully managed, the aircraft's stability at low speed would let a pilot decelerate close to landing speed on final approach and deploy the drag 'chute seconds before touch-down. When handled correctly, the F-102 would usually come to a halt within 1000 ft of where it initially touched down.

When losses did occur in the early stages of the jet's service life, engine failure or landing gear breakages were responsible more often than flight control difficulties. In all, ADC lost 107 F-102As and 12 TF-102As in a steadily reducing annual total that culminated in two accident-free years – 1971 and 1972 – for the final squadron, the 57th FIS. However, the unit would suffer the last F-102 loss (56-1321) on 22 January 1973, seven months before it converted to F-4Cs and more than three years after the original deadline for the inactivation of all ADC 'Deuce' squadrons. Over the icy northern wastes, the twin-engined Phantom IIs offered greater hope of recovery following the failure of one engine.

At Ethan Allen AFB, the 37th FIS with F-86D 'Dogs' transitioned to Delta Daggers at the end of 1957. Two senior pilots went to Griffiss AFB

TF-102A 56-2346 of the 332nd FIS moves carefully over impacted snow at Thule AB in February 1964. The 'Tub's' side-by-side seating required repositioning of the throttle controls for the instructor pilot in the right-hand seat to the right side of the cockpit, rather than the usual left side location. He therefore had to fly the aircraft with his left hand on the control column. 56-2346 ended its flying career (in December 1975) with the Pennsylvania ANG's 146th FIS, after which it became a gate guard at Muir Army Airfield, also in Pennsylvania (*Terry Panopalis*)

for a TF-102A 'Tub' check-ride followed by F-102A solos, giving them about ten hours in all. They then made up their hours by ferrying new 'Deuces' from Palmdale to other bases where squadrons were swapping over to the Delta Dagger. Before the 37th FIS's formal conversion course began, the unit's two senior pilots who had spent time at Griffiss were rated as instructors on-type after accruing 25 hours on the aircraft. Three more pilots took two TF-102A check-rides and a single-seat solo at Griffiss, after which they also assisted ex-F-94 pilots in single-seat radar techniques based on their knowledge of the E-4 system in the F-86D and its similarities to the MG-10.

The 37th FIS's full complement of 'Deuces' had arrived by the end of 1957, including several jets that were updated from the original batch of flight test aircraft. Many of the latter contained redundant wiring, which created numerous maintenance problems compared with later production specimens. Some of these airframes were eventually passed to F-102 United States Air Force in Europe (USAFE) units in West Germany. In 1959 the 37th FIS took over the newer and more reliable F-102s of the 498th FIS.

Ground controllers worked on the assumption that a pair of F-102As could reach 35,000 ft within three minutes of take-off, and take about ten minutes to ascend to their maximum ceiling of 54,000 ft if necessary. Targets had to be met between 600 and 800 miles off-shore to allow time for a follow-up attack. At 40,000 ft an F-102A could proceed to an interception at Mach 1.25 in level flight – fast enough to intercept the Soviet Union's mid-1950s range of subsonic bombers. Interception would require a straight-line route to the target, with turns needed only to make a reverse after a beam attack and fire an IR missile in a stern pursuit. With a large delta wing, more strenuous manoeuvres would bleed off energy and speed too fast.

As part of the conversion process pilots had to be fitted for MC-4 Partial Pressure suits, and their associated oxygen inflation gear and survival kits, for high-altitude interceptions. For maintainers, keeping the MG-10 system with its vacuum tube modules operational was their most persistent headache, although they also devoted overtime to the hydraulic pumps in the flight control system. There were also temporary restrictions on afterburner use in mid-1958 when afterburner liners burned through, causing tailpipe fires. Meanwhile, pilots had to get used to a nose-wheel steering button which doubled as a microphone control until the nose was raised on take-off and the weight came off the nose-gear.

Missile testing and training was not without risk either. In 1958 an 82nd FIS pilot accidentally shot down a T-33 trainer that was supposed to be providing a 'target' for a WSEM (evaluator missile) test. Instead, the F-102A released three Falcons, and one of them removed the T-33's rudder. Luckily, both crew survived ejection from 43,000 ft.

Attrition in the northern-based units remained low despite the appalling climatic conditions in which many squadrons were working. Flying at night, in poor weather with the cockpit blacked out and closing in to FFAR-firing distance on an invisible, fast-moving bomber target was undoubtedly one of the hardest jobs in military flying at the time. The 27th FIS had its first fatality since 1952 when the controls of Capt Jack

The 59th FIS 'Black Bats' at Goose Bay Airport, Labrador, flew F-94s and then F-89s prior to converting to the F-102 in 1960 – the unit would operate 'Deuces' for six years. Pristine F-102A-80-CO 56-1488, complete with a modest-sized 'bat on the moon' insignia on its fin, soaks up the sun at Suffolk County AFB, New York, next to a Vermont ANG F-89D in September 1965 (*Terry Panopalis*)

Pittman's F-102A froze after hydraulic failure on 28 June 1959 and the aircraft entered a steep dive from which he was unable to eject in time. Two months later a 47th FIS F-102A from Niagara Falls Municipal Airport, New York, unaccountably exploded two minutes after take-off, killing 1Lt John Flynn. Towards the end of its time with Delta Daggers, the 27th FIS organised a night-time radar interception practice mission involving three pairs of 'Deuces' and a high-flying T-33 radar target. During the second pair's attempt, the T-33 was lost from the ground controller's radar screen and moments later three of the pilots saw a huge explosion. One of the F-102s had collided with the target aircraft, killing its back-seater and the 'Deuce' pilot, 1Lt Gary Sugar.

ADC was re-named Aerospace Defense Command on 1 January 1958, by which point the F-102's days as its premier interceptor appeared to be already numbered since its successor, the F-106A Delta Dart, had completed a relatively trouble-free development period compared with the Delta Dagger. After its first flight with a USAF pilot at the controls on 29 April 1957, when the F-106 reached Mach 1.9, the new aircraft was enthusiastically welcomed by ADC.

The USAF's disappointment with some aspects of the F-102, particularly its performance against 'target' high-speed bombers, U-2s and RB-57D reconnaissance aircraft above 40,000 ft, had been made clear in an ADC evaluation at the end of 1957 in which it stated that, 'The F-102 weapons system did not provide ADC with an acceptable combat capability. Further, lengthy conversion schedules caused a marked degradation in air defense.' In many simulated attacks by SAC aircraft the interception rate had been lamentably poor, particularly at high altitudes, but many of the problems originated in the ground-control procedures rather than with the fighters.

In Alaskan Air Command the F-102A's endurance became a problem in March 1963 when two 317th FIS aircraft scrambled from the unit's forward base at King Salmon to intercept a Soviet Tupolev Tu-22 bomber that had overflown part of western Alaska. They had to turn back 20 miles from the target when their fuel ran low – an incident

which led to the rotational deployment of longer-legged F-106s to the 317th's home base at Elmendorf AFB, Alaska, from July 1963.

The F-102's success rate was sometimes worse in the late 1950s than contemporary F-89s and F-86s, but it was, after all, an 'Interim Interceptor'. The 'Ultimate' F-106 was then still experiencing some development problems and would not be available in quantity for at least a year. Difficulties with fuel feed (also present in the F-102A), acceleration and the highly sophisticated Hughes MA-1 weapons control system occurred during the USAF's Category II tests up to June 1959. The side-stick control column (tested in the F-102A) was rejected in favour of a standard F-102A type, and re-design of the unsatisfactory ejection seat had to be delayed until after service entry.

Delta Dart deliveries to the 498th FIS, which had flown F-102s for only two years, began in May 1959. However, it was clear that budget limits, with F-106s costing three times as much as F-102s, would not allow the USAF to equal its purchase of 1000 'Deuces' and equip 40 squadrons with F-106s as it had originally intended. ADC was in fact invited to choose between cancellation of the F-106A or the F-101B. As a compromise, both programmes continued, but with a limit of 26 Delta Dart squadrons sharing a total purchase of 340 F-106As and two-seat F-106Bs. Ultimately, only 20 frontline ADC squadrons and two training units eventually received the Delta Dart, and it also subsequently equipped six ANG units, compared with 23 that operated F-102s.

ADC was, in any case, being reduced in size following a policy change which recognised that mass Soviet bomber attacks were far less likely than individual bombers (carrying hydrogen bombs) at low altitude, or attacks by intercontinental ballistic missiles. By the end of 1960 15 ADC squadrons had been inactivated.

In 1958 the USAF's regular World-Wide Weapons Meet was re-named William Tell to reflect the growing importance of radar-guided interception techniques. That same year the competition introduced an F-102 category that remained until 1974, with 34 'Deuce' teams competing during that time. In order to use rocketry and guided weapons effectively, William Tell was moved from Yuma Proving Ground, Arizona, where it had been conducted since its instigation in 1952, to Tyndall AFB, where it was hosted by the 4756th ADW (Weapons). Missiles, including AIM-4 Falcons and AIR-2 Genies, could be fired safely over the Gulf of Mexico range.

The 1958 event was divided into classes for the different types of fighter involved, and it included interceptor squadrons from the USAF in Europe, the Alaskan Air Command, Pacific Air Forces, Air Training Command and the ANG, all of whom would become F-102 operators. Each team of four pilots flew a total of 16 sorties, 12 of them involving live firing of missiles against air-launched Q-2A Firebee target drones at altitudes ranging from more than 40,000 ft to below 1000 ft. Firebees were capable of 600 mph and they could climb above 50,000 ft and photograph incoming air-to-air missiles or emit countermeasures against them. The 1958 F-102 class was won by the 326th FIS 'Sky Wolves' from Richards-Gebaur ('Dicky-Goober' to its military residents) AFB, Missouri.

For the 1959 William Tell, the 525th FIS from USAFE at Bitburg AB, West Germany, sent crews – but no jets – to train for the event at

Ethan Allen AFB, where they arrived laden with gifts from Europe. They duly borrowed two 37th FIS aircraft (including 56-1479), which they temporarily redecorated with a large Maltese cross incorporating their bulldog motif on the vertical tail and their crew nameplate delta stencils on the nose. The 525th's efforts were rewarded by being placed second among six teams in the F-102 category. That year also saw IR GAR-2 and AIM-9B (then known as GAR-8) missiles introduced to the competition.

From 1975 onwards, although F-102As continued to appear at William Tell, they did so only as target drones.

GIN AND GIUK

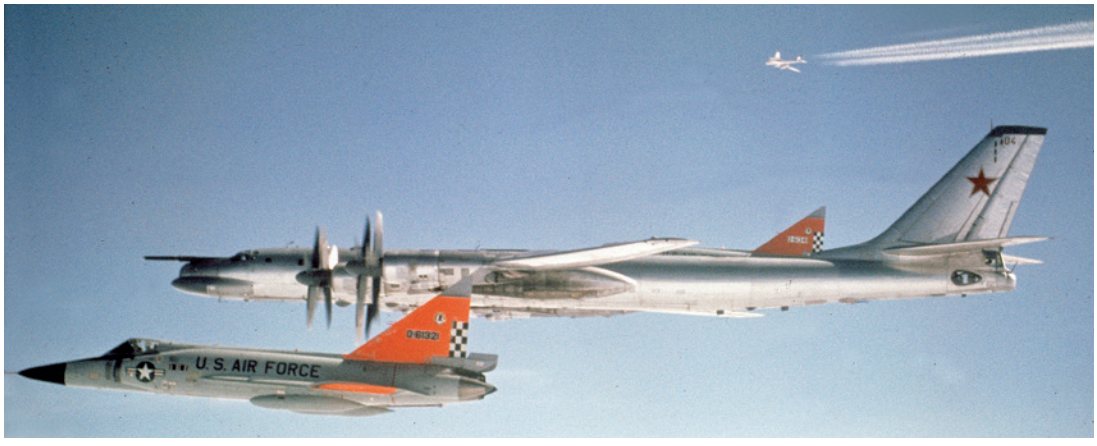
By far the longest-serving ADC F-102 unit was the 57th FIS 'Black Knights of Keflavik', which converted from Scorpions to 14 F-102s in 1962. It had been the last interceptor unit in the frontline to fly the F-89D, operating them for two years longer than the majority of Scorpion squadrons, which relinquished their aircraft in 1960 – some soldiered on in ANG service until 1969, however. Its F-89Ds were so weary that instead of them being flown back to the USA following their replacement, they remained at Keflavik as fire-fighting and rescue training hulks. Eleven years later, as the last ADC 'Deuce' unit, it transitioned to F-4Cs.

The 57th's location at Keflavik, in Iceland, and its longevity made it the most successful of all the northern F-102 units in terms of the number of Soviet bombers and reconnaissance aircraft that it intercepted over the so-called Greenland-Iceland-United Kingdom (GIUK) gap – a vital route for Soviet military air traffic. There was a steady increase in these encounters throughout the early 1970s, with 347 recorded by the end of 1970. In September 1972 the 57th FIS became the first USAF squadron to pass 1000 interceptions. It averaged 150 interceptions of Soviet aircraft per year, particularly during large NATO exercises such as *Northern Wedding*.

F-102A-80-CO 56-1455 returns to Keflavik to complete another 57th FIS Cold War mission. Landing the 'Deuce' was aided by the 'cushion' of air beneath its big delta wing. A pilot had to flare the aircraft and settle on the cushion until the main wheels made contact with the runway, at which point he would deploy his drag 'chute (*USAF*)

Tu-16 'Badgers' and Ilyushin Il-18 'Coots' were commonly encountered, as well as the very frequent Tupolev Tu-95 'Bears' based in the Kola Peninsula which more usually flew close to the Norwegian coast but would sometimes approach the Icelandic Air Defense Identification Zone (ADIZ) at low altitude and be intercepted by Keflavik aircraft. They were detected by North American Aerospace Defense Command (NORAD) radar stations just north of Keflavik or near Höfn, in southeast Iceland. ADIZ extended for 200 miles from the coast of Iceland, which is halfway between New York and Moscow and in the middle of the Greenland-Iceland-Norway (GIN) gap that contains vital NATO shipping lanes. This 'gap' also gave the Soviet Union maritime access to the Atlantic and North Sea.

After approaching and identifying their regular 'guests' – often Tu-95 'Bears' – pilots had to move in close enough to photograph any modifications to the aircraft, record any changes in antenna configuration or visible reconnaissance equipment, and then stay with the



Inside the Iceland Identification Zone in 1970, a pair of 'Black Knights' (56-1321, lost off Iceland in a fatal crash on 22 January 1973, and 56-1341) keep a close watch on a Soviet Tu-95KD 'Bear-B', while a second 'Bear-B' turns away for the long flight home. At that distance the deep throb of the Tu-95's engines would have been felt in the cockpit of the F-102A (*Terry Panopalis*)

intruders until they were clear of the ADIZ. Data-link became available during the squadron's final years of service with the F-102. Like their equivalent squadrons in the USA though, many of the 'Black Knights" scrambles were made to identify stray private aircraft or airliners that had not appeared in the local flight plans.

The F-102A worked well in the sub-zero conditions of Iceland and Alaska. The cold, dense air made afterburner take-offs shorter, although landing on ice-covered runways was inevitably a challenge. It was not unusual for aircraft to slide off the runway or taxi-ways and end up in a snowdrift. Wearing numerous layers of clothing and thick gloves in case of a bail-out over arctic waters made for an uncomfortable ride in the cockpit. However, it gave pilots some hope that they might extend the official four minutes of consciousness that they could expect if they landed in water without that extra protection. Occasionally, pilots were told to sit cockpit alerts in temperatures below -20°F, awaiting scrambles that were never needed.

The Cuban Missile Crisis in October 1962 added another dimension to the F-102 units' responsibilities. The 482nd FIS, which flew F-102s from Seymour Johnson AFB, North Carolina, from 1956 to 1965, detached aircraft to Miami International Airport and Naval Air Station (NAS) Key West, Florida, from December 1961. They replaced a detachment of 'Deuces', on alert with nuclear AIM-26 missiles, from the Air Defense Weapons Center (ADWC) at Tyndall AFB that was similarly placed on guard against Soviet Ilyushin Il-28 tactical bombers based in Cuba that could have attacked Cuban refugees in the Miami area.

By October 1962 the entire 482nd FIS was based at Homestead AFB, Florida, and it supplied interceptors on five-minute alert to respond to any attack alongside F-101Bs, F-104As and F-106As of other units. Forty-nine F-102s were assigned to Homestead, and an alert presence was maintained at NAS Key West from June 1963 until July 1965, when the responsibility reverted to ADWC F-102s until November 1969. By that stage their nuclear AIM-26 missiles had been omitted, although 2.75-in rockets had been reinstated and test-fired at a derelict US Navy ship target near Key West.

The Elmendorf-based 317th FIS also became involved in the Cuban Missile Crisis on 27 October 1962 at the height of the political tensions.

317th FIS F-102A-70-CO 56-1274 approaches a NORAD radar installation in June 1968. After ANG service and use as a drone, when it was declared an operational loss in August 1979, this aircraft returned to Elmendorf for static display. Early F-102 service with ADC revealed continuing maintenance and reliability problems ranging from exploding engine starters to jammed nose-wheel steering and frozen parachutes – if rain leaked into the braking 'chute compartment the parachute could freeze at high altitude and fail to deploy, leading to an arrested landing (*USAF*)

SAC U-2A pilot Maj Charles Maultsby inadvertently strayed into Soviet airspace after becoming disorientated by the Aurora Borealis, preventing him from taking accurate star fixes for navigation. 317th FIS F-102As, armed with nuclear AIM-26As, were sent from their forward base at Galena, Alaska, to rescue him from the six MiGs which had been scrambled to shoot the U-2 down. Luckily, Maultsby, now out of fuel and gliding down from 70,000 ft, escaped in time to avoid a confrontation. The F-102A pilots escorted Maultsby back to a friendly airfield at Kotzebue, Alaska, where he made a flamed-out landing.

Galena AB was the starting point for interceptions of 23 Soviet aircraft by 317th FIS Delta Daggers between 1961 and 1969. In 1965 the squadron received the Hughes Trophy for its successful interceptions, although it was inactivated three years later and most of its aircraft transferred to the Wisconsin ANG's 176th FIS.

USAFE

Flexible Response was a strategy implemented by President John F Kennedy in 1961 as a counter to the New Look national security policy of massive strategic nuclear retaliation favoured by his predecessor, President Dwight D Eisenhower. In USAFE, the adoption of the new strategy saw 164 ex-ADC F-102s posted to Europe to equip six squadrons. All charged with defending central Europe, two units were based in Spain, three in West Germany and one in the Netherlands. The squadrons were under the control of the Seventeenth Air Force's 86th AD, with Headquarters at Ramstein AB, and the Sixteenth Air Force's 65th AD, headquartered at Torrejon AB. They were joined at various points by ANG units such as the 151st FIS of the Tennessee ANG and the 197th FIS of the Arizona ANG, both with F-104s, which were at Ramstein in 1961.

The two 65th AD squadrons, the 431st FIS at Zaragoza and the 497th FIS at Torrejon, were responsible for an area from Spain to Turkey. As compensation for the use of the Spanish bases, aviation company CASA at Moron AB was given maintenance contracts for USAFE F-102s, with other firms within the Spanish aircraft industry being awarded contracts for similar maintenance work. The F-102s' role ended when the Spanish air force took over the air defence of its own country in 1964.

Before delivery, the 164 aircraft (excluding 18 for the 525th FIS) passed through the Air Materiel Areas at San Antonio, Texas, San Bernardino, California, and Mobile, Alabama, where they received updates to their MG-10 systems to FIG-5 standard, TACAN installations, provision for drop tank carriage and a complete re-spray with Aircraft Gray paint, before being cocooned and shipped to France aboard aircraft carriers in

December 1958. The removal of the protective latex cocooning on arrival sometimes damaged the new corrosion-resistant paint, which had to be restored at the Sud-Aviation factory in France.

Eleven shipments were made in all by October 1960, and the first batch of 18 went to the 525th FIS 'Bulldogs' in January 1959 at Bitburg AB, West Germany. Like the other USAFE squadrons, it received aircraft that were mainly from a single production block due to variations between blocks. The Hahn-based 496th FIS began to receive F/TF-102As to replace its F-86Ds in December 1959 and the 497th FIS at Torrejon had its first aircraft in April 1960. At Ramstein AB, the 526th FIS 'Black Knights' swapped its F-86Ds for F-102s from June 1960, and it would be the last USAFE 'Deuce' operator, exchanging its aircraft for F-4Es in April 1970. The 431st FIS at Zaragoza had a shorter time with the Delta Dagger. It commenced conversion from the F-86D in 1960 and was subsequently inactivated in 1964. One of the unit's regular commitments during this period was giving Sixth Fleet carrier-borne US Navy attack squadrons experience of fighter interception as they made practice low-altitude strike sorties against Spanish bases from 100 miles off the Portuguese coast.

The sixth squadron, the 32nd FIS 'Wolfhounds', was based at Camp New Amsterdam, Soesterberg, in the Netherlands. In 1958 the unit was taken over by the legendary Korean war ace and author of the fighter pilot's textbook *No Guts, No Glory*, Lt Col Frederick 'Boots' Blesse, who oversaw the squadron's transition from the F-100C to the F-102 in 1959, when the 32nd moved from the day-fighter role to air defence. Blesse was regarded as a hard taskmaster in managing the squadron. One of his innovations was the distinctive unit patch that combined a cartoon wolf's head with the Dutch wreath and crown insignia. The unit had an unusual role in Europe's air defence, as former pilot (and Vietnam MiG killer) Lt Col Bill Swendner explained;

'Soesterberg was in a unique situation as the Queen of the Netherlands wanted an American fighter squadron stationed in Holland. Although the 32nd was under NATO control, she demanded that it should become part of the Royal Netherlands Air Force [RNLAF]. Since the Dutch didn't have any F-100s, we were assigned to the 36th TFW at Bitburg AB for supply and logistics [the unit was later transferred to the 86th AD at Ramstein AB]. Operationally, however, we answered to Dutch Fighter Command. The Dutch wing commander had operational control over the 32nd FDS [Fighter (Day) Squadron], and further up the line was the commander of Dutch Fighter Command, Gen von der Wolfe.

'The 36th TFW tried to get us to send six F-100s to Germany for an exercise, and our operations officer asked if they had checked with the Dutch first. When he did so he got a phone call from the Dutch wing commander saying, "Forget it, you aren't going anywhere". The same procedures were in effect after we got the "Deuce" and were switched to the 86th AD – we were operationally under Dutch control and logistically assigned to the 86th AD. We had nothing to do with the other squadrons in Germany or Spain. Our area of responsibility was always the Netherlands.

'At that time the squadron was day fighter designated. We pulled daytime alert duty from a little shack next to the runway about once every couple of months as the alert duty was moved around from base to base. We would

get scrambled by the Dutch-manned "Stovepipe" GCI [ground-controlled interception] site via a field phone. We were separate from the Dutch Hawker Hunter [No 325 Sqn, RNAF, equipped with Hunter F 6s] alert facility. The base was divided by the runway. The 32nd FDS was on one side and the main part of the base was on the Dutch side, with separate facilities. The only thing we shared apart from the runway was that every morning we had to drive over to the Dutch side to get the morning weather briefing. That requirement carried over when we got the F-102.

'I extended my three-year tour for another year, and while I was there we transitioned to the "Deuce" in 1960. Along with the "Deuce" we had an influx of ADC-type pilots. At one time we had 60 pilots on base, both F-100 and F-102 qualified, but we soon began to lose F-100 guys who were rotating back to the States, while some ADC types went on to Germany. We continued to fly both types of aircraft, checking out in the F-102 at Wheelus AB, Libya.

'They built a big new alert facility with a high-speed taxiway to the runway at Soesterberg, and we started to pull air defence alert on a rotating basis with Dutch F-86Ls from two other bases, and later [from February 1961] we went on 24-hour, five-minute alert full-time. We had two birds in the alert hangar and two spares on the ramp. "Stovepipe" controlled us, even when we flew into Germany, Belgium, northern France and over the English Channel, and we never got a "hand-off" to any of the other sites around that part of Europe. Even with the F-102, the field closed at 1600 hrs and didn't open until 0800 hrs, and it was closed at the weekends. We didn't fly at night, the only exception being an active scramble from "Stovepipe".'

At that time Lt Col Swendner had 900 hrs on the F-100 and 200 on the F-102, allowing him to compare the two century series fighters;

'We F-100 pilots liked to hassle with other aircraft, and basically anything in the air was fair game, but we would have had a tough time fighting against the Hunters, Luftwaffe F-86s and Canadian Sabre Mk 6s unless we used the vertical plane and lots of afterburner. The "Deuce" could turn with a Hunter, but the visibility out of the cockpit was very poor. The canopy was slanted and there was a big beam directly over the top and

Although the 32nd FIS at Soesterberg was focused on defending the Netherlands, the colour scheme of its 'Deuces' echoed those of other contemporary USAFE F-102 squadrons – the unit did, however, later incorporate the RNLAF crest in its tricolor tail scheme. F-102A-55-CO 56-1032 was retired by the 159th ANG of the Florida ANG to the MASDC in September 1974, and it was subsequently converted into PQM-102B '734' and written off at Tyndell AFB in November 1979 (*Terry Panopalis*)

no rearward visibility. Maintenance was always bitching at us because the "Deuce's" radar evidently didn't like g-forces. Whenever I had a flight where I got into a hassle with another aircraft, I wrote up the radar as being inoperative when I landed. It would just go blank for some unknown reason.

'I preferred landing the "Deuce" to the F-100 on that standard 7600-ft European runway, especially when it was wet, which it was for most of the winter. The "Deuce" flew finals at around 135 knots, as opposed to the F-100C at 170-175 knots. Although neither had flaps, that big delta wing made a difference.'

TF-102A-15-CO 54-1363 has the 32nd FIS tricolour tail, the clog motif that adorned many Soesterberg-based Delta Daggers in 1962-63 and an appropriate nickname for a big-canopy 'Deuce'. The choice of cockpit arrangement was influenced by the need for aircrew to also work in Link simulators, used for training on the ground, with a similar seating arrangement. This aircraft was lost after it suffered an inflight fire on 11 December 1973 while serving with the Florida ANG's 159th FIS (*Author's collection*)

The 32nd FIS did eventually share the alert facility with No 325 Sqn Hunters, but not until November 1963. One aircraft (56-0973) was lost near its base in thick fog and another (56-1029) was written off after a fire in the jet's alert hangar caused by an explosion in its engine starter. The unit's F-102s were upgraded with Hughes IRST installations in 1964, giving them better interception capability in the difficult ECM conditions that they could encounter in European airspace – pilots frequently trained with USAFE RB-66C ECM aircraft to improve their skills in that area.

The 32nd's sphere of action also widened in the mid-1960s, with training detachments to Torrejon AB and to Erding AB, in southern West Germany, where it supplied a six-aircraft alert flight after defecting Soviet pilot Lt Vasily Ilych Epatko ejected from his undetected MiG-17 nearby on 22 May 1967. Two years earlier, the 'Wolfhounds' had become the first USAFE unit to fly back to the USA when six aircraft made the journey to take part in the September 1965 William Tell competition. Their team leader was Capt Paul Bakker, RNAF, and the pilots spent two weeks at Perrin AFB undertaking extra training ahead of the competition. This duly paid off as they took first prize in that year's F-102 category. In 1968 the 32nd FIS set a record for the fastest turnaround of an F-102, refuelling, rearming, topping up and inspecting an aircraft in just 7 minutes 32 seconds. It also won the NATO/AFCENT Air Defence Competition in both 1966 and 1967 after coming second in 1965, as well as the Hughes Achievement Award for the most outstanding air defence unit in the entire USAF in 1966.

In 1969 the 32nd FIS became the first USAFE interceptor squadron to receive the F-4E. TF-102A 55-4035, which had flown with the California ANG before being passed on to the *Türk Hava Kuvvetleri* (Turkish air force), is preserved at the Dutch Military Aviation Museum at Soesterberg along with F-102A 56-1052 (with fake '56-1032' serials) as a reminder of the 'Deuce's' time in Holland.

With all USAFE squadrons in place by August 1961, Europe faced a period of political insecurity that same month when construction

commenced on the Berlin Wall. Twenty-eight ANG units were put on active status, and Operation *Stair Step* took the F-102As of the South Carolina ANG's 157th FIS to Moron as extra protection for SAC bases there. The 151st FIS of the Tennessee ANG and the 197th FIS of the Arizona ANG flew to Ramstein AB to work with USAFE interceptor units and three deployed ANG F-104 Starfighter squadrons in defending the four Air Defense Sectors of Central Europe.

Germany-based F-102s were fully engaged in regular interceptions of unidentified aircraft in the border corridor between West Germany and the Soviet bloc countries. Although the contacts were usually civil aircraft with navigation problems, military pilots from both sides routinely strayed into hostile airspace for varying periods of time, triggering scrambles by F-102s or MiGs. NATO aircraft were sometimes instructed to make feint high-speed runs at the border, forcing Soviet radar operators to respond, thereby revealing details of their radar capability.

At Bitburg, the 525th FIS, like other USAFE fighter squadrons, began its regular weapons training deployments to Wheelus AB with newly delivered F-102s from July 1959 – such evolutions could involve more than 20 aircraft. Here, pilots made live missile launches, including the first use in USAFE of the GAR-1D updated, semi-active Falcon against a radar-reflective Delmar target towed by a B-57 bomber or F-100. Updates to the aircraft and their radar systems were generally managed by Fiat at Turin-Caselle, in Italy, or at the French Breguet factory at Chateauroux, which worked with the San Antonio Air Materiel Area in Texas.

USAFE F-102s were fitted with barrier arresting hooks by Breguet in 1961-62, and a 525th FIS 'Deuce' was the first to use it at Bitburg in July 1963 after a tyre blew out on take-off. The squadron also received USAFE's first F-102 in 'Vietnam' camouflage in October 1965. Routine depot-level maintenance, including the application of camouflage, was the responsibility of CASA at Seville-San Pablo. Hughes personnel assigned to the Spanish company installed classified radar components, and by 1965 most F-102s had received data-link equipment (modified aircraft boasted twin antennas beneath their tails), anti-collision lights, external fuel tank pylons and upgraded engines and ejection seats. The 526th FIS flew half

Sixteen of Bitburg's 525th FIS F-102s are lined up for a parade and inspection. No doubt the alert barns were still manned by another flight of 'Deuces' at the time (*USAF*)

Lined up for Exercise *Big Lift* in November 1963, these two red-and-white-tailed 526th FIS aircraft are being 'prepped' for another sortie. *Big Lift* was one of many exercises held to demonstrate how quickly NATO assets could be reinforced from the USA. F-102A-65-CO 56-1210 has its ram-air turbine (RAT) auxiliary power unit extended beneath its belly. The RAT automatically deployed if engine rpm fell below 70 per cent in flight, and it provided enough pressure to operate the flying controls down to 180 knots (*USAF*)

of the sorties needed to establish and calibrate the European Air Weapons and Control System – a radar network that incorporated data link.

Unlike the 497th FIS in Spain, which lost no aircraft in four years of F-102 flying, the Germany-based squadrons had their share of mishaps. Undercarriage and hydraulic failure, engine fires and iced runways took their toll, causing five losses. The 526th FIS's 55-4059 (an ex-18th FIS TF-102A) crashed after an engine fire on 8 June 1967, and the squadron lost another in a mid-air collision and three others in crashes between 1961 and 1968. The 496th FIS at Hahn AB was even less fortunate, losing six aircraft (three to engine failure and two due to control problems). The pilot of F-102A 56-1121 exhibited great flying skill when he managed to land his aircraft after a mid-air collision with a Dornier Do 27 utility aircraft that severed most of a wing from the latter and killed both crew in the resulting crash.

The pilot of 525th FIS F-102A 56-1253 faced a dilemma when his brakes failed and he ran off the main runway after landing. He had to maintain engine power to retain nose-wheel steering, which was very necessary as his jet rolled at high speed towards a parked F-104. He managed to steer round it, but was still heading for the control tower. Another F-102 then loomed up ahead of him, although its pilot got out of his way and he then decided to return to the runway, head for the barrier arresting gear and extend his hook. The wandering 'Deuce' was finally halted without damage.

The 525th FIS relinquished its long-serving F-102s to ANG units in October 1969, six months before the 526th FIS 'Black Knights' at Ramstein brought F-102 operations in USAFE to an end on 1 April 1970. Fifty-eight aircraft from USAFE units had already returned to the USA in mid-1964 under Operation *Krazy Kat*, some of them being replaced by newer aircraft. The 'Black Knights' had begun their European stay with a prolonged Wheelus AB deployment in October 1960, eventually assuming alert status in November and rapidly accumulating record numbers of flight hours despite the unit's Ramstein AB being notorious for bad weather – winter detachments to sunnier Spanish bases were always welcomed.

The 496th FIS suffered from similar weather conditions at its Hahn base, and extensive runway work from 1960 to 1963 necessitated the

deployment of its 'Deuces' to Bitburg, Torrejon or Ramstein for extended periods. The unit also operated from Erding AB between 1966 and 1969. The Erding deployments were made partly to cover gaps left by France's withdrawal from NATO in 1966. After ten years at Hahn, the 496th's 22 F-102As were flown back to the USA for their new owners, the 194th FIS of the California ANG. The 'Deuce's' lengthy tenure in USAFE was due partly to a shortage of F-4C/Ds, which were scheduled to replace F-102s. Vietnam War demands kept many USAF Phantom IIs at Southeast Asian bases until 1970.

The two Spanish-based 65th AD squadrons had the principal responsibility of safeguarding the regular Project *Reflex* deployments of SAC B-47 Stratojets to Zaragoza AB up to 1964 – the 497th FIS was in fact temporarily assigned to SAC in 1960. Like other USAFE squadrons, it took its turns at Wheelus AB, scoring particularly good results in high and low-level interception in 1962 following its selection for the 1961 William Tell, which was cancelled due to the Berlin Crisis. At Zaragoza, the 431st FIS, with its very distinctive hand-painted red 'devil head' tail art (designed in 1961 by Airman Stephen Chianese) and white-sidewall tyres, also achieved high scores at Wheelus, with outstanding results in interceptions and missile launches within a single day. In July 1962 it was certified to carry the AIM-26 version of the Falcon.

Like other F-102 squadrons, the 431st FIS experienced engine fires and undercarriage failures. In one accident an engine explosion jammed open the throttle of a taxiing F-102, propelling it into three other parked aircraft. The crash of TF-102A 55-4038 (as a result of engine failure) on 8 September 1961 took the life of the squadron commander, Lt Col Joseph McCabe, who drowned in the Mediterranean Sea.

Another disaster was averted on 12 December 1963 when Capt Henry Mills followed F-102A 56-1012 from which the pilot had ejected after the engine flamed out. Mills noticed that the pilotless fighter was turning towards villages and he manoeuvred his aircraft close to the 'Deuce'. Using a World War 2 trick invented by pilots who flipped V1 'Doodlebug' missiles into terminal dives, Mills used the cushion of high-pressure airflow over his wingtip to gently lift the wingtip of the gliding F-102, making it turn away from danger. Several times he had to move to the other side of the aircraft to apply the same trick until the aircraft crashed harmlessly into a field.

At Hahn AB in 1964, the 496th FIS abandoned its sunburst tail markings (yellow and black in this case) like other USAFE F-102 units for a simple band in squadron colours, although traces of the sunburst remained on the speed-brake housing. F-102A-60-CO 56-1053, seen here with a lightning bolt marking in unit colours on an underwing drop tank, was eventually retired to the MASDC in March 1975 following service with six squadrons (three of them assigned to the ANG). It is presently displayed in the Alaska Heritage Park at Elmendorf AFB with the incorrect serial '56-1274' (*Terry Panopalis*)

PACAF 'Deuce' crews dash to their aircraft for a practice scramble. Colourful squadron markings gave way to plain ADC Gray paintwork and a simple PACAF crest as soon as the five squadrons based in Japan and the Philippines began to send detachments to Vietnam and Thailand (*USAF*)

CHAPTER FIVE

ON GUARD WITH PACAF

Seven squadrons within the Pacific Air Forces (PACAF) flew F-102s from bases in the Far East between 1959 and 1971, although only one, the 509th FIS, operated them for almost all of that time. Within a complex command structure that covered a vast geographical area and incorporated the USAF's Fifth Air Force (headquartered in Tokyo), Seventh Air Force (centred in Hawaii), Eighth Air Force (Kadena, Okinawa), Thirteenth Air Force (at Clark AB in the Philippines) and Twentieth Air Force (based on Guam), this was a relatively small air defence element. From July 1957, headquarters for the entire PACAF organisation was located at Hickam AFB, Hawaii.

Four interceptor squadrons in Japan converted from F-86Ds to F-102s. Lacking in-flight refuelling to make the long journeys to their PACAF bases, the new aircraft had to be laboriously cocooned and transported by sea. In 1959 the 16th FIS, with black-and-white chequered tails, was stationed at Naha, Okinawa, with the first of the PACAF F-102s. The 68th FIS 'Lightning Lancers' had converted to the 'Deuce' at Itazuke AB by December of that same year. In 1960 the 4th FIS 'Fightin' Fujins' received red chequer-tailed F-102s at Misawa AB and the 40th FIS – another Delta Dagger unit with a devil's head marking – exchanged its Sabre 'Dogs' for 'Deuces' at Yokota AB. At the same time the 509th FIS was reactivated at Clark AB, where it would become the most important F-102 operator in PACAF.

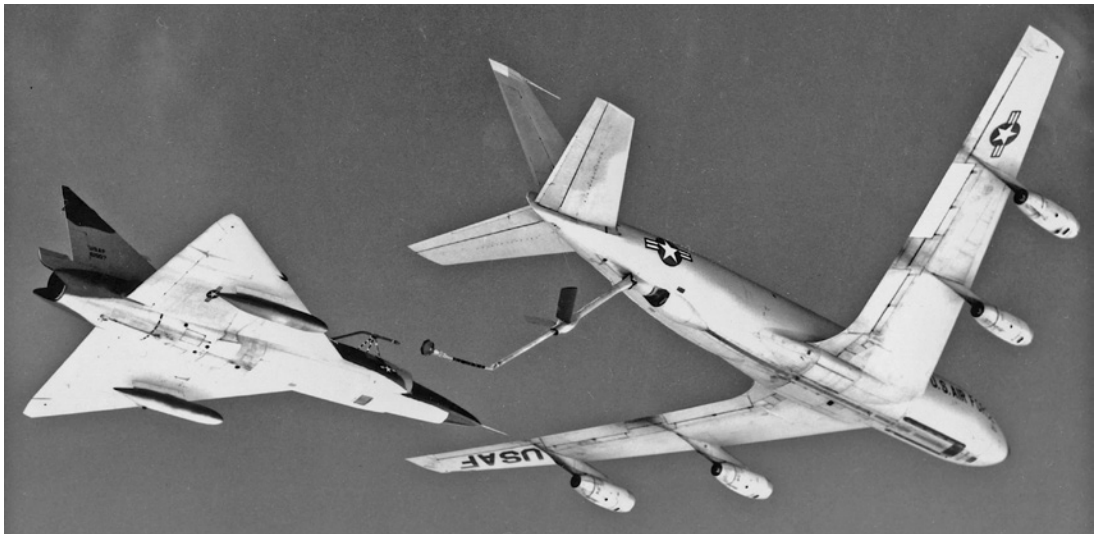
In addition to providing Japan's air defence, PACAF F-102s were used to fulfil US obligations to Thailand under a 1950 military assistance agreement. Increasingly hostile communist activity on the Thai border with Laos prompted the first 'Deuce' alert detachment, provided by the 509th FIS in August 1961. Four F-102As were despatched to Bangkok airport, which doubled as Don Muang Royal Thai Air Force Base (RTAFB), in Operation *Belltone*, relieving F-100Ds of the 510th TFS. This arrangement was to continue until mid-1970 as an air defence commitment that was initially sustained with a minimum of local technical and logistical support and an absence of radar and ground control facilities. The 24 aircraft used for the deployments, together with their crews, were regularly rotated back to Clark AB, where the F-102s' maintenance took place.

The planned tenure of the Japan-based 'Deuce' units was reduced in 1963 as part of Project *Clearwater* – a policy designed to curtail Far East deployments and make the countries that hosted the bases shoulder more of their own responsibility for air defence. During 1964-65 the four Japan-based F-102 squadrons were inactivated, and the 509th FIS/405th FIW at Clark was scheduled to close down in 1966. All four F-102 units duly began conversion to the F-4C as tactical fighter squadrons, leaving the 509th FIS as the only local F-102 operator, with a large complement of extra aircraft.

However, this policy of reduction proved to be premature as the Vietnam War gathered pace and the 509th had to be kept in place. It was in fact reinforced at Clark in 1966 by the ADC's F-102-equipped 64th FIS 'Scorpions' in Project *Hot Spice*. At the same time the 82nd FIS was transferred from Travis AFB, California, to the 51st FIW at Naha in Project *Thirsty Camel*. Transport by sea could take up to seven months, so in order to hasten the deployment both squadrons' aircraft – in Vietnam camouflage – were modified with bolt-on kits for aerial refuelling. The elaborate pipe-work for a temporary in-flight refuelling system was devised by Convair at the end of 1965 and eventually fitted to 58 F-102As (including those of the 64th, 325th and 326th FIS) and a single TF-102A at the Air Materiel Command facility at McClellan AFB, California. The equipment was removed after a transpacific flight, for it reduced the aircraft's performance by at least one-tenth.

This makeshift refuelling probe, designed to mate with the probe-and-drogue refuelling method, was also fitted to 29 of the 82nd FIS's 'Deuces' at San Diego. After some practice with KC-97 and KC-135 tankers, it became the first F-102 unit to fly across the Pacific in Operation *Deuces Wild*. The 82nd was in place at Naha AB by mid-February 1966, replacing the F-4C-equipped 555th TFS 'Triple Nickel', which was transferred to Udorn RTAFB, Thailand.

The 64th FIS 'Scorpions', from Paine Field, Washington, acquired aircraft with in-flight refuelling modifications from a variety of sources and made the flight to the Philippines in the same way. The route flown by the unit took it to Hickam AFB, onward to Andersen AB, Guam, and thence to Clark AB. On the longest leg, from Hamilton AFB, California, to Hawaii, the pilots had to top up their tanks constantly in case they developed refuelling problems and either had to turn back or press on to Hickam. Each tanker had two dependent 'Deuces' all the way. Negotiating



F-102A-80-CO 56-1507 of the 82nd FIS moves in to accept fuel from a KC-135E through its temporary in-flight refuelling system, en route to Naha AB, Japan, during Project *Thirsty Camel* in February 1966. Vietnam camouflage included a 15-inch diameter national insignia beneath the right wing, although, as with this jet, it was not always applied (*USAF*)

some massive tropical storms en route, the squadron arrived at Clark intact and was ready to share air defence duties with the 509th FIS under the control of the 405th FIW by mid-June 1966.

All the deployed F-102s had IRST sensors and retained nuclear missile capability, but their data-link equipment and antennas were removed as there was no SAGE system in the Far East. They also had an extra 10.5 US-pint liquid oxygen converter fitted in the missile bay to provide sufficient breathing oxygen for the transpacific journey.

In-flight refuelling provision for the aircraft of the 325th FIS at Truax Field, Wisconsin, was intended to enable them to deploy to Misawa AB, but a change of plan occurred when it was decided that their absence would delay the ANG's transition to the F-102. The deployment, Project *Tall Tale*, was cancelled in May 1966. The 325th FIS was then inactivated and the modified aircraft diverted to the 82nd and 64th FISs for their transpacific journeys.

The new squadrons were put in place mainly to help the 405th FIW in providing detachments to bases throughout Southeast Asia, just as their predecessors in Japan had done. The extra work challenged Clark AB's ability to sustain so many extra responsibilities. These included Project *Bone Deep*, which had overseen the defence of South Korea by F-102 detachments since 1963. For the 82nd FIS, its most important new off-base activity was a temporary deployment (TDY) to Suwon AB, South Korea, following the seizure of the US Navy intelligence-gathering ship USS *Pueblo* (AGER-2) and its 83-man crew by the North Korean navy on 23 January 1968. A detachment of F-102s, with their NV tail-codes applied over new 'Vietnam' camouflage paint, stood alert at Suwon throughout the crisis, reinforced by rotational detachments of PE-coded jets from the 64th FIS.

F-102As from Suwon came close to open conflict with North Korean air force MiG-21PFMs on 15 April 1969. The MiGs had been moved from their Puk'ang-Ni home to the forward base at Hoemun-Ni on the east coast of North Korea. The reason became clear when US Navy Lockheed

EC-121M Warning Star BuNo 135749 'Deep Sea 129' of VQ-1, based at Naval Air Facility Atsugi, Japan, was intercepted on its 'Beggar Shadow' 8.5-hour electronic reconnaissance mission heading back towards Osan. It was flying 80 miles off the North Korean coast over international waters when one of the MiG-21s struck the unarmed aircraft with 'Atoll' air-to-air missiles. Thirty-one crew, including the pilot, Lt Cdr James Overstreet, were lost and only two bodies were recovered.

Two minutes before the fatal interception Brig Gen Arthur Holderness, commanding the USAF's 314th AD, had ordered a pair of F-102As to scramble from Osan and escort the EC-121 past the area of potential threat. Sadly, the fighters arrived too late. It may have been a coincidence that North Korea was celebrating the birthday of its leader, Kim Il-Sung, that day.

The majority of wartime duties for PACAF 'Deuces' involved the defence of US facilities in South Vietnam and a range of escort, weather reconnaissance and ground attack missions for which this supersonic interceptor was never designed.

The first possibility of action in the interception role occurred as early as March 1962 when a radar station near the US Army helicopter base at Pleiku picked up several aerial movements over the Central Highlands of South Vietnam. Two weeks later more radar traces were reported coming from Cambodia, but no aircraft were seen in either case. However, a four-aircraft detachment of the 509th FIS was sent to the already overcrowded Tan Son Nhut AB near Saigon, in South Vietnam, with instructions to intercept and shoot down any aircraft intruding into South Vietnamese airspace.

It was known that the Vietnamese People's Air Force (VPAF) had received eight Il-28 'Beagle' medium bombers for its 929th Air Battalion from the Soviet Union (although they were not in service until mid-1965), and there were also fears that China might send its bombers across the border to attack American facilities. In fact, the North Vietnamese Il-28s did not make their first and only attack until October 1972 – by which time just two remained in service – when they damaged an airstrip in Laos. A more feasible threat came from possible attacks by slow, low-flying helicopters or aircraft such as Antonov An-2 'Colt' biplanes that could conceivably approach well below radar coverage. Two of these ungainly aircraft were shot down by US Navy F-4Bs in 1966, but F-102 pilots never had the chance to catch one.

The four Operation *Water Glass* F-102s at Tan Son Nhut practiced interceptions regularly, but there were no further suspicious radar sightings and the 'Deuces' were ordered back to Clark in May 1963 on the understanding that they could be recalled to South Vietnam with minimal notice. Occasional return visits to Tan Son Nhut did occur throughout 1963 at times of political unrest, but with no sign of an aerial threat, Project *Clearwater* proceeded as planned and the F-102 was still scheduled to vanish from PACAF during 1964, with the 68th and 16th FISs as the first units to be cut.

All that was changed by the Gulf of Tonkin incident on 2 August 1964 when two US Navy destroyers were attacked by North Vietnamese torpedo boats and President Lyndon Johnson ordered retaliatory attacks. He also instigated a major increase in US air power in South Vietnam,

including F-100s, B-57s and two detachments of F-102s. Six 509th FIS aircraft arrived at Da Nang AB on 5 August, while another six from the 16th FIS were flown to Tan Son Nhut, operating as a detachment of the 405th FIW. Both detachments were strategically placed to protect the South Vietnamese capital, together with key US assets at Da Nang and in the central area of the country, from air attack. At Da Nang, they came under the GCI direction of the big US Navy early-warning radar site on 'Monkey Mountain' (Son Tra Mountain), and they were able to refine their 'scramble' times until they could get airborne in 2.5 minutes.

Pilots were on alert for 72 hours, followed by 24 hours of 'down time'. Two aircraft were always on five-minute alert, with a second pair on 15 minutes notice and a back-up pair on one-hour alert. Radar traces of supposed intruders from the north continued to appear through 1965, prompting 24 scrambles in the detachment's first three weeks on duty but no aircraft sightings.

The initial emergency situation early in 1964 subsided, no VPAF intrusions occurred and the reduction in F-102 squadrons proceeded as planned, leaving the 509th FIS as the sole – very busy – 'Deuce' operator in-theatre. With an inflated total of 42 F-102s on charge, the Clark-based 509th began to supply regular 90-day Operation *Candy Machine* detachments to Tan Son Nhut, Bien Hoa and Da Nang in South Vietnam and Udorn and Don Muang in Thailand.

Although their role was ostensibly air defence, the direct threat of North Vietnamese or Chinese air attack never really materialised, so pilots were able to use their skill, experience and ingenuity to supply a range of unexpected support activities instead. At Da Nang, these involved providing MiGCAP escort for the 6252nd TFW, which was active there from July 1965 through to April 1966. This wing included the 509th FIS, which shared top cover duties with F-104Cs of the 436th TFS for the B-57Bs of the 8th Bombardment Squadron and other units until they were replaced in that role by the F-4Cs of the 390th and 480th TFSs in February 1966. However, demands on the Phantom II squadrons increased to the point where an F-102A air defence detachment had to be re-established at Da Nang in mid-1967.

Although considerably faster than the F-102As, the Starfighters that shared the MiGCAP role with the 'Deuces' at Da Nang carried only two AIM-9B missiles. They did have an internal M61A1 cannon, however, which could have been more useful for any close-in MiG encounters than the F-102A's wider range of missiles. Like their counterparts flying the Delta Dagger, F-104C pilots were similarly disappointed in their hopes of aerial victories and also lost one jet to a MiG on 20 September 1965. Capt P E 'Smitty' Smith was shot down by a pair of Chinese air force J-6s (MiG-19s) when he strayed too close to Hainan Island during an escort mission for an EC-130E-II Silver Dawn intelligence gathering aircraft.

North Vietnamese troop incursions into South Vietnam gathered pace at the rate of 4500 per month throughout 1966 and Adm Ulysses Sharp, commander of all Pacific forces, requested a further 486,500 US troops and 16 tactical fighter squadrons, together with 61 more reconnaissance aircraft, for the war effort by the end of that year. Several F-100 squadrons were consequently pulled out of USAFE and three more F-102 units, including the 82nd FIS at Okinawa, were scheduled for permanent basing

OPPOSITE
64th FIS F-102-75-CO 56-1343 is seen at McClellan AFB in May 1966 with the bolted-on in-flight refuelling kit installed in 86 F-102s for the Project *Thirsty Camel* deployments to the Far East. The squadron flew F-102s with ADC from McChord AFB, Washington, from 1957 to 1960, moved to Paine Field, Washington, for six years and then transferred to Hamilton AFB, California, to prepare for its Southeast Asia deployment. 64th FIS aircraft were camouflaged and modified for combat operations in-theatre (including the removal of SAGE equipment) and equipped for in-flight refuelling in Project Hot Spice (*Terry Panopalis*)

This early detachment by the 509th FIS to Tan Son Nhut AB, South Vietnam, included F-102A-65-CO 56-1165, which was later destroyed in a Viet Cong sapper attack on Bien Hoa AB on 21 May 1967. Although revetments at South Vietnamese air bases gave some protection against mortar and rocket attacks by helping to contain fires and explosions, open cockpits like those seen here were a temptation to insurgent saboteurs with grenades or satchel charges to throw. The 509th provided the first detachments to South Vietnam and Thailand in 1962, and the unit remained in Southeast Asia until its deactivation in 1970 (*USAF*)

in South Vietnam. In practice, the reduced risk of North Vietnamese air attack meant that the deployment of more detachments was continued, instead of causing further overcrowding at South Vietnamese bases by moving entire squadrons.

By 1967 24 F-102As were on alert duty at bases in South Vietnam and Thailand, two of the aircraft specifically tasked with protecting the King of Thailand from air attack. More mundane duties included escorting transport aircraft that took visiting politicians, celebrities and military dignitaries on their inspection tours. Escort duties could also involve more demanding flights into hostile territory to accompany battle-damaged aircraft, such as solo reconnaissance RF-4Cs or RF-101Cs, back home to a safe landing.

The influx of *Thirsty Camel* and *Hot Spice* F-102s enabled new rotational detachments to operate from Udorn from April 1966. As the South Vietnamese bases rapidly turned into some of the world's most active airfields, their resident squadrons had to be moved around to avoid severe overcrowding. For Gen Hunter Harris Jr, who, as commander of PACAF, had the responsibility for the air defence of the whole region, the ability to move F-102 detachments quickly to areas of need was a valuable asset. He also found that the second line of base air defence – batteries of MIM-23 Hawk surface-to-air missiles – could also be installed quickly.

Indeed, a 315th AD effort moved a Hawk battery from Okinawa to Da Nang and made it ready for action within 48 hours.

The Tan Son Nhut F-102A detachment was transferred to Bien Hoa AB in November 1966, remaining there until 25 September 1968 when it was returned to Clark, but it was then kept on 12 hours' notice of re-deployment to South Vietnam. During 1967-68 at least 14 F-102s were always on five-minute alert throughout the war zone, and others were kept at one-hour notice of deployment. Although that need hardly ever arose, the logistical demands on the parent squadrons were very considerable. Nevertheless, the supply of support items and spare parts was kept at a better level than for some more heavily utilised aircraft types.

Extra tasks for 'Deuce drivers' included escort duties for some of the incessant *Arc Light* B-52 missions flown over Laos and southern North Vietnam. A pair of F-102s would fly ahead of the Stratofortress cell at 35,000 ft if it ventured north of the demilitarized zone (DMZ), pilots attempting to trigger and identify enemy early-warning or air defence radars. If it was clear that the B-52s had been 'seen', the bombers could be rapidly diverted to secondary targets in a safer area. The few TF-102As (including 55-4036) in-theatre were also called upon to photograph the effects of some of the devastating B-52 attacks in South Vietnam in December 1965.

As bomber escorts, the Delta Daggers had the advantage of good radar and GCI to meet the incoming *Arc Light* cells approaching from Guam or southern Thailand, and the acceleration to react rapidly to any threat to the bombers by day or night. The F-102's supersonic cruise rate was faster than a fully loaded F-4 and its armament at that time, although unproven in combat, was roughly equivalent to the Phantom II. However, it lacked the latter's in-flight refuelling capability.

In August 1968 a 30-day interdiction plan was devised to attack choke points on the supply routes through three mountain passes that led from North Vietnam into Laos. It included up to 300 daily sorties against the Song Giang-Song Troc river complex and Routes 15 and 137, with 24 *Arc Light* B-52s, accompanied by four F-102 and eight F-4 CAP fighters, in the vanguard of the strikes.

Some F-102 missions (specifically MiGCAPs for aircraft and helicopters undertaking rescue attempts for downed aircrew) took them across the North Vietnamese border – on one occasion to within 35 miles of Hanoi. However, they were kept out of close escort duties for Operation *Rolling Thunder* strikes partly because it was thought that their delta-wing profile resembled the MiG-21's enough to cause possible misidentification in a fight, but also because the 'Deuce' could not be refuelled in flight. However, Delta Dagger pilots provided the counter-argument that their aircraft was cheaper to operate and service than the twin-engined F-4C. F-102As shared with F-104Cs some of the escort duties for EB-66 and EC-121 ECM aircraft, as well as guarding the KC-135s' refuelling tracks.

Like the TDY F-104 detachments at Da Nang and other Southeast Asian bases, the 'Deuces' were required to fly weather reconnaissance missions ahead of air strikes. In a theatre of war with intense monsoon conditions and no strike aircraft with substantial all-weather capability, the presence of clear weather on the in-flight refuelling tracks and target areas for the F-105s and other *Rolling Thunder* strikers was crucial. Bad

weather was by far the most common reason for cancelled or aborted strikes, but it did not ground the all-weather F-102s. The early morning weather reconnaissance flights by solo F-102s, usually from Udorn, were therefore a crucial, although unpublicised, aspect of their wartime effort. Commanders often awaited the 'go' or 'no-go' message from a 'Deuce' pilot before deciding whether to launch a strike or divert to a secondary target.

IR ADVANTAGE

During 1965 the US war effort became increasingly focused on the frustrating attempt to stop supplies and arms from North Vietnam being transported along the Ho Chi Minh Trails network to insurgent forces in the south. Most of the traffic travelled by night, and it was decided that the F-102's well-established and (in Southeast Asia) unique IR detection capability might pick up small heat sources for targeting purposes. The jet's AIM-4 IR missiles and its IRST installation, which was never used on air defence sorties, could be used to contribute to the searches for endless processions of vehicular and pedestrian traffic through the forests.

Although externally-carried detection and targeting pods for tactical aircraft, together with heat-seeking air-to-ground missiles, were still in their infancy, during Operation *Stovepipe* F-102s were used to try and detect hot-spots in the jungle caused by cooking fires, vehicle engines or troop concentrations. Pilots of F-104s and F-105s had scored occasional hits with IR AIM-9B Sidewinders on vehicles emitting heat from their engines, and the same tactic seemed an appropriate, though expensive, use for the AIM-4D Falcon.

If a target was detected, the 'Deuce' pilot could launch his 12 2.75-in rockets or even an AIM-4D IR missile at it, albeit from a hazardously low altitude in pitch darkness. Pilots suffered the additional problem of a temporary but disorientating loss of night vision caused by the glare from multiple rocket blasts as the missiles were launched. Although their weapons' small warheads were unlikely to cause much damage, F-102 pilots were usually able to enlist the help of an accompanying B-57 Canberra bomber if any secondary explosions were triggered by the rockets and missiles.

These rocket-launching sorties extended into daytime attack and close support missions too. Tactical aircraft regularly used 2.75-in FFARs for this purpose, although they were usually carried in 19-shot LAU-3 pods, with up to six pods per F-4 or F-100, rather than the dozen rockets in the internal tubes of an AIM-26-modified F-102A. In practice, the high-explosive/armour-piercing warheads used on air-to-ground versions of the FFAR were longer than the F-102's usual type, so the load was halved.

The 'Deuce' was considered to be a very accurate launch platform for the FFARs, although the rockets themselves had to be fired at close range in order to achieve any kind of accuracy. However, their use obviously contributed to Washington's daily tally of sortie rates and ordnance expended – one of the principal measurements of the success of the war effort in the US government's estimation. In the second half of 1965 'Deuces' from Tan Son Nhut introduced these tactics, and by the end of the year more than 600 'day fighter' sorties had been flown.

Maj John Postgate, an F-102 pilot himself, also did a Vietnam tour as a forward air controller (FAC);

'As a FAC in South Vietnam, while on a visual reconnaissance mission in 1966 I got a call from an F-102 pilot that he wanted to expend his 2.75-in FFARs on a ground target. I found him a target and he kicked up a lot of dust and went home happy that he had got in on the war.'

509th FIS F-102A-41-CO 55-3369 on the taxiway at Clark AB in 1967. This squadron, like both the 64th and 82nd FISs, sent detachments to Suwon AB during the 1968 Pueblo Incident (*Terry Panopalis*)

Results were hard to observe, but many similar missions probably achieved little more than causing acid corrosion to the F-102s' rocket tubes due to unusually high utilisation that was totalling more than 100 sorties per week for the South Vietnam detachments. In order to increase the 'Deuce's' ground-attack versatility, a Da Nang-based 509th FIS aircraft was fitted with SUU-11/A pods containing GAU-2 7.62 mm mini-guns on triple ejection racks TERs suspended from its drop tank hard-points in August 1966. This experiment was short-lived as structural concerns ruled out its use in combat, for which the modification would, in any case, have offered little offensive power.

Convair sought to expand the F-102's capability in the ground-attack role and suggested additional wing pylons for conventional bomb loads and possibly an internal gun, but the USAF already had enough fighter-bombers. Even so, for an interceptor squadron, the 509th FIS's tally of ground targets destroyed was creditable. In one 45-day period it flew 199 combat sorties, during which it destroyed 106 buildings and damaged 59 others. It also knocked out a bridge and sank 16 sampans with rocket fire.

This high utilisation and the risks of close-in ground attacks inevitably brought losses, although only one of the 15 aircraft destroyed was confirmed as being brought down by ground fire during a rocket attack. Two were hit by sniper fire on take-off or landing and four were destroyed by Viet Cong (VC) sappers in air base attacks on Da Nang and Bien Hoa. Although the F-102's 'wet wing' made it particularly vulnerable to small-arms, little damage was actually caused by such hits. Indeed, far more destruction was caused by sabotage.

At Da Nang, sappers mounted a diversionary night-time attack on 24 November 1964 to occupy the guards, allowing the VC to insert a demolition squad that lobbed satchel charges into the open cockpits of three alert status F-102As and fired automatic weapons into their tailpipes. A USAF policeman was killed and several F-102 maintainers, who had attempted to defend their charges with M16 guns, were wounded. Three 509th FIS jets (56-1161, 55-3371 and 56-1182) were burned out and three others were damaged, in addition to the loss of two C-130A Hercules flare-droppers. Other aircraft on the flightline were damaged by rockets released from the burning F-102As.

In a second attack on Bien Hoa on 12 May 1967, losses were caused by 189 rounds of mortar fire that killed six personnel, destroyed Vietnamese

Air Force aircraft and 509th FIS F-102A 56-1165, together with an F-100D and an O-1G Bird Dog FAC aeroplane. However, engine failure was the most persistent cause of losses, with five and possibly six cases leading to operational losses.

MiG CLASH

MiG activity in 1965 was sporadic as the VPAF squadrons continued to refine their tactics against the *Rolling Thunder* attacks that began in March. By the end of that year the more capable, missile-armed MiG-21 was established in service with the 921st Fighter Regiment (FR), bringing the total inventory of MiGs to around 75.

US escort fighters venturing over the North Vietnamese border risked meeting MiGs, although many pilots never saw one in hundreds of flights over hostile territory. On their escort sorties the F-102 pilots occasionally received warning of approaching MiGs, and the operation to set up the famous Lima Site 85 on a mountain at Phou Pha Thi, in Laos, was one such occasion. The powerful radar and Heavy Green TACAN site was established to provide *Rolling Thunder* attacks venturing deep into North Vietnam with better radar coverage than the US Navy's offshore radar picket vessels could provide.

The heavy equipment to set up the site had to be carried by CH-3 and CH-47 helicopters to the top of the 5600-ft karst Black Mountain. Two Udorn-based F-102As were sent to escort the helicopters across the Plain of Jars towards the mountain. A MiG warning was received from the US Navy 'Motor Pool' offshore radar warning vessel and the USAF College Eye early-warning EC-121 aircraft patrolling in the area. F-102As, led by Capt Robert Donaldson, headed for the MiG-21s that were flying towards them from the Dien Bien Phu area.

Climbing in afterburner, the lead 'Deuce' pilot picked up the MiGs on radar at 30 miles and prepared his missiles, awaiting approval to fire from the GCI controller, who would be the only source of permission to attack the MiGs. At 20 miles range permission had still not been given, and as the pilots approached visual range they saw that the MiGs were turning away and descending. Capt Donaldson suspected that they might have been bait to lure the 'Deuces' into a fight with a greater number of MiGs, but the USAF pilots were, in any case, told to return and guard the helicopters.

A less auspicious MiG-21 encounter occurred on 3 February 1968 when two 509th FIS F-102As were flying an EB-66 escort mission at 36,000 ft near the North Vietnam–Laotian border at Sam Neua. Maj A L Lomax was the 'Jersey White' flight leader, with 1Lt Wallace Wiggins as his wingman. At the VPAF's Noi Bai airfield, 921st FR pilots Pham Thanh Ngan and Nguyen Van Coc (who would end the war as the top VPAF ace with nine kills, including five F-105Ds) took off on their fourth interception mission of the day, heading for a pair of enemy aircraft that had been detected on radar near Moc Chau.

As they approached the Laotian border, Ngan thought he saw a distant EB-66 ECM aircraft, but closer examination revealed the two F-102As. Lomax saw the MiGs, turned and fired three AIM-4D Falcons, all of which missed. Ngan manoeuvred into the blind spot behind Wiggins' aircraft (56-1166) and triggered an R-3S (K-13A 'Atoll') missile, which remained stubbornly on its launch rail, but his second weapon hit the

F-102A's tail. Van Coc also fired a missile, but it failed to guide correctly. The MiG-21F-13s were then ordered to break off the engagement.

Wiggins reported a problem with his aircraft, and when Lomax checked it he saw the body of the unexploded 'Atoll' protruding from the Deuce's rear fuselage. Lomax attempted to locate the MiGs again, but they rapidly departed and moments later he saw Wiggins' aircraft explode and disintegrate in flames. No ejection was attempted. It was the only F-102 loss to a MiG, and also a reminder of the problems faced by a 'Deuce' pilot – principally missiles that took 16 seconds to set up and minimal visibility from the cockpit – when caught by surprise by an expertly flown MiG-21.

The increasing numbers of Phantom IIs, including the gun-armed F-4E version, committed to the conflict in Southeast Asia enabled the F-102 alert detachments to stand down. By then the USAF was facing a shortage of experienced pilots for the 'Deuce', so it established the *Palace Alert* programme to give ANG F-102 pilots a chance to fly a 90-day tour with the PACAF squadrons. Presidential decisions had prevented whole ANG F-102 squadrons from deploying to the area, but several ANG pilots flew alert missions in 1969 as part of *Palace Alert*. One of the pilots who applied was future president 2Lt George Bush of the Texas ANG's 111th FIS, but he lacked the required 500 hours of flying time stipulated by PACAF.

The Da Nang aircraft returned to Clark AB in April 1969 and the detachments at other South Vietnamese bases followed on 17 November 1970. Thai detachments lasted a little longer, but during the summer of 1970 they too were returned to the Philippines. The long-serving 509th FIS was inactivated at Clark AB in July 1970, its war-weary 'Deuces' being sent to Naha AB for scrapping. The 64th FIS was inactivated on 15 December 1969. The majority of its aircraft were scrapped at Clark AB as a cheaper alternative to transporting them back to the USA. The final PACAF F-102 squadron, the 82nd FIS, soldiered on until 31 May 1971, when its aircraft – many of them showing signs of structural fatigue – were also scrapped at Naha AB, thus terminating the 'Deuce's' lengthy period of service in Southeat Asia.

Their valuable air defence support had been unspectacular, and generally ignored by the media as its deterrent effect in preventing air attacks on American facilities was inevitably hard to assess. Like so many other US aircraft types, the 'Deuce' was also required to perform missions for which it was never intended. US Navy F-4s, for example, were also conceived as bomber interceptors – a role they never performed in action. However, the design of the Phantom II was sufficiently versatile to be adapted for a wide variety of tactical fighter and reconnaissance missions.

The F-102 design was essentially frozen in 1956 after extensive development and reconfiguration proved to be so costly that no further evolution could be funded. In its Ultimate Interceptor (F-106) form, the Convair delta reverted to the specialist interceptor role for which it was ordered, but en route the 'Deuces' and their crews in Southeast Asia demonstrated a surprising degree of adaptability. Like the F-104C with which it shared escort and alert duties, the F-102's success was measured in terms of deterrence rather than the aerial combat that brought fame to other fighters such as the F-4. The award of the Hughes Trophy for 1968 to the 64th FIS as the outstanding USAF fighter squadron of that year brought at least some public recognition of the 'Deuce's' contribution.

CHAPTER SIX

ON GUARD AT HOME AND AWAY

A tight formation of Oregon ANG 'Deuces' from the 123rd FIS 'Red Hawks' with their simple gold tail flashes and SAGE antennas beneath the rear fuselages of two aircraft. The unit flew F-102s for five years until March 1971. All of these aircraft apart from the flight leader's 56-1369 were later converted into drones (*USAF*)

The re-establishment of the USAF's ADC in 1951 gave it control of 21 fighter squadrons, and two more were soon added. In addition, 21 ANG units were placed under federal control, providing 'runway alert' aircraft to supplement the frontline air defence units. A single US Navy interceptor squadron protected southern California using the F4D Skyrays of the Pacific Fleet's west-coast all-weather training unit.

Although the tradition of individual states operating their own aviation units originated in 1908, the integrated ANG had been formed in September 1947 as a separate national defence organisation from the USAF, which in turn had been established just two months earlier. The ADC became the gaining service for the ANG's fighter and light bomber units whenever they were required in the national interest.

Five squadrons received the ANG's first jets in the form of F-80 Shooting Stars in 1948, and by 1956 18 ANG wings had the very successful F-86 Sabre while other units operated F-80s, F-89s and F-94s. The F-51D Mustang was still also used by eight wings. There were six fighter-interceptor wings, and these increased to eight in 1956 with the availability of the F-86D radar-equipped Sabre. 1958 brought a further capability boost with the acquisition of supersonic F-100As for two squadrons and missile-equipped, all-weather F-89H Scorpions for 11 units, allowing the establishment of 43 jet fighter-interceptor squadrons. Twenty-nine of them operated F-86D/L Sabres, and they

included the interceptor units scheduled for further modernisation with supersonic fighters in the form of the Mach 2 F-104A and, from 1960, the F-102A.

Cuts to the military budget by the Eisenhower administration placed increased reliance upon the ANG and in 1958 brought forward plans to introduce four F-102 units, while NORAD at the same time aimed to have 19 ANG 'Deuce' squadrons in place to reinforce ADC units on America's northern and southern borders and to replace older interceptors. This could only be achieved by inactivating 12 ADC units and transferring their F-102s to ANG squadrons. In July 1960 the ANG fighter-interceptor squadrons were 'gained' by ADC, to be called to active service whenever required. F-102 introduction proceeded rapidly, and by 1961 23 out of the ANG's 32 fighter interceptor squadrons had Delta Daggers.

The first four F-102 ANG units were established from 4 June 1960, initially equipping the 182nd FIS of the Texas ANG at Kelly AFB, San Antonio, as part of ADC's 33rd AD. Although the unit's 'Lone Star Gunfighters' nickname hardly fitted the missiles-only F-102, the squadron continued to uphold the fighter tradition that it had established as the first ANG unit to enter combat. Texas had two fighter squadrons, both previously flying F-86Ls. The second, the 111th FIS, received its first Delta Daggers in August 1960 at Ellington AFB in Houston and was tasked with defending the Texas Gulf coast. The ANG accepted that Texas and California needed two squadrons each in view of their geographical extent.

Ten years later, the 111th FIS 'Ace in the Hole' became the CCTS for all ANG 'Deuce' pilots, adding the training of F-101 crews to its syllabus and continuing in the Delta Dagger business until January 1975. In 1971 it took over all F-102 training from the USAF's 4780th ADW at Perrin AFB when that unit closed down.

During the 1950s Texas ANG squadrons had also begun to initiate the 'Texas Plan', whereby Guardsmen could undertake their training flexibly at times to suit them, rather than concentrating it into summer camps as other units had done. However, that innovation was curtailed by the 1961 Berlin Crisis. Among the Ellington AFB trainees in December 1969 was 2Lt George W Bush, future governor of Texas and the 43rd president of the USA. He completed 16 weeks of training in the F/TF-102A, graduating in June 1970 and remaining with the 111th FIS as a pilot until October 1973. He flew alert scrambles and exercises totalling 336 hours with the unit.

Four other squadrons were in the process of transitioning to the F-102A in 1960-61, and they, like the Texas ANG units, remained in the USA to boost ADC's capabilities. The 159th FIS 'The Boxin' Gators' of the Florida ANG, the 122nd FIS of the Louisiana ANG, the 146th FIS of the Pennsylvania ANG and the 175th FIS 'Lobos' of the South Dakota ANG had converted by the end of 1960. That period included six weeks of intensive training for 150 122nd FIS personnel at the Gulfport Combat Readiness Training Center. These units were followed in 1961 by the 199th FIS of the Hawaii ANG, which would become the longest-serving F-102 user with sole responsibility for the air defence of the Hawaiian island complex – a task which is performed in 2020 by the squadron's

F-22A Raptors. Three of these units transitioned from the F-86L, while the 'Lobos' relinquished F-89D/Js and the 'Boxin' Gators' experienced a major technical advance from their previous F-80Cs.

For pilots coming from other types to the 'Deuce', it often looked very impressive. Jerry Key, who went on to fly F-100s, was given a TF-102A ride during his basic training, following experience with the T-33;

'It was such a thrill and, of course, the F-102 was several steps above the T-33 in terms of performance with its afterburner, and it had side-by-side seating so I could see out of it much better. The pilot even let me fly it a little. He showed me how he did an intercept and shot a missile. It was only a simulation, but he pulled the nose up about 30 degrees, said he had a lock-on, fired the shot and then did a split-S manoeuvre. I was hooked. I knew that beat flying straight and level from A to B any day.'

'DEUCES' DEPLOY

By 1966 21 ANG units were operating 340 F/TF-102As, and most kept their 'Deuces' at least until the early 1970s, with transitions from previous types occurring up to 1972 in the case of the New York ANG. The F-102 units usually comprised 25 aircraft, including two TF-102As. They mounted alert flights for the US mainland and Hawaii around the clock for 17 years and provided background security by filling in for deployed frontline units during periods of international tension such as the 1962 Cuban Missile Crisis and the Berlin Wall challenge by the Soviet Union the previous year.

For the Berlin Crisis in the summer of 1961, 31 ANG units were mobilised and eight were operating from European bases within five weeks of mobilisation, including three F-104A interceptor units. The Mach 2 Starfighter had been released to ANG units because the USAF decided its avionics were not sufficiently advanced for the ADC all-weather interception role. Based at Ramstein and Moron ABs, the F-104s worked alongside the 86th AD F-102s which were cleared for the employment of nuclear-tipped AIM-26A Falcons during that emergency. In the tense atmosphere of the Berlin confrontation six ANG squadrons were also allowed to adapt their F-102s for nuclear Falcons.

After Berlin, two more ANG squadrons converted to 'Deuces'. The 151st FIS of the Tennessee ANG was formed in 1957 with F-86Ds, but it soon transitioned to F-104As and deployed to Ramstein AB in October 1961 together with the Starfighters of the 197th FIS of the Arizona ANG. Rather than returning the Starfighters to state service on their return home, the USAF decided it needed them for other units, so the Tennesseans got F-102As and the Arizona squadron had to convert to slow, but vital, KC-97L tankers. Arizona did not receive 'Deuces' until 1966, but for its 152nd FIS 'Tigers' rather than the 197th FIS. Following the conversion, the 'Tigers' received a USAF Distinguished Unit Citation for completing the process within ten months – the fastest transition at that time.

The 157th FIS 'Swamp Foxes' of the South Carolina ANG had also converted to the F-104A, and it took the fighters to Europe in November 1961, deploying to Moron to protect SAC B-47 bases in Spain. After the Cuban Crisis the unit also had its Starfighters repossessed by the USAF to provide additional air defence with the 319th FIS at Homestead AFB and

to equip an F-104 training unit at Webb AFB, Texas. It had been decided that the Starfighter's lack of sophisticated all-weather systems would not be a problem in the climate of the southern states. In their place, the 'Swamp Foxes' received Project *Clearwater*-released PACAF F-102s in June 1963, operating them for almost 12 years.

The Tennessee unit's tenure as a 'Deuce' squadron was much shorter. After only 13 months of flying the aircraft from its Knoxville base, the 151st FIS was required to convert to KC-135Rs and become an air refuelling squadron in 1964.

Capt David Diffenderfer was one of the 152nd FIS pilots who converted to the 'Deuce' from the F-100A;

'I transitioned to the F-102A at Tucson International Airport, Arizona. Our mission was for ADC on the southern border, along with the "Tacos" [188th FS of the New Mexico ANG]. We converted to the "Deuce" and they went to Tactical Air Command. I was checked out on the F-102 at the ANG unit in South Carolina [157th FIS]. The F-102 was easy and stable to fly compared with the F-100, but a lot less fun. It was also ineffective against any radar countermeasures. We would practice night interceptions against B-52s and they would take our lock-on steering dot [on the cockpit radar screen] off themselves and drop it in the middle of nowhere. I never did splash a night target. So, without a gun, it was ineffective.

'The best fun we had in the F-102 came when we found an F-4 from Davis-Monthan AFB and persuaded him to engage us. We could always out-turn the Phantom II, but without a gun it was a moot point. My best memory was when after a trip to Tyndall AFB to fire missiles, our 162nd FIG commander, Don Morris, led a three-ship formation take-off to return to Tucson. Incidentally, the F-102 had the same glide ratio as a Boeing 707. I was flying both in those days.'

During the next international crisis, the Cuban Missile affair in October 1962, the ANG F-102 units were dispersed to various forward bases – including one in Alaska – to reduce their vulnerability to attack and also to increase the range of point defence options for potential targets on the US mainland.

In 1964-65 three more ANG squadrons took on Delta Daggers. The 194th FIS 'Griffons' of the California ANG began the transition process from F-86Ls in July 1964 at Fresno Air Terminal, thus commencing a ten-year association with Delta Daggers that ended with their replacement

This F-102A-75-CO is seen towards the end of the California ANG's time with the 'Deuce' in 1974. At that time the rear fuselage was overpainted in grey and the nose anti-dazzle was extended in a curved style that was then fashionable among USAF and US Navy fighter squadrons. Metal areas of the intake ramps were also grey and a Western Air Defense pennant was displayed beneath the serial. Passed on to the Pennsylvania ANG's 146th FIS shortly after this photograph was taken, 56-1360 was flown to the MASDC in late 1975. Converted into a PQM-102A, the aircraft was shot down over the White Sands Test Range by a surface-to-air missile in August 1977 (*Author's collection*)

by F-106 Delta Darts. The following year California's other interceptor unit, the 196th FIS at Ontario International Airport, also exchanged its SAGE-linked F-86Ls for F-102s, and it too enjoyed a decade of 'Deuce' flying. The 196th was one of the last ANG units to move on from the F-86. April 1964 saw the 190th FIS of the Idaho ANG exchange F-86Ls for F-102s at Gowen Field, Boise, thus beginning a long period with the type leading to transition to RF-4C Phantom IIs late in 1975. The 190th had extensive experience as an interceptor unit, having flown F-94Bs and F-89Bs since 1956.

Although ANG F-102s were not directly involved in the defensive measures put in place during the Cuban Missile threat, its repercussions continued into 1971 when a Cuban airliner suddenly appeared near New Orleans asking for landing instructions. Because it had unwittingly and embarrassingly penetrated all the USA's southern air defences, additional F-102 detachments from the California, Florida and Texas ANGs were sent to bases in the south to increase the protection.

SUPERSONIC NIGHT INTERCEPTION

Lt Col Frank W Trojcak flew with the 149th FIG of the Texas ANG from 1962 to 1986, including during most of the group's nine years with the F-102. Its two 'Deuce' squadrons had a large area to cover, but some of their tasks proved to be unusually demanding;

'The tactic for supersonic interceptions at night above 45,000 ft was devised by "higher headquarters" at a time when there was a possibility of attack by aircraft of a foreign nation with supersonic capability. Our unit was located in the central Texas area, facing possible attack from hostile units located in the Gulf of Mexico or southern nations. It was a very dangerous mission, and in one instance we lost our unit commander in a mid-air collision with one of the F-102 interceptors. The interceptor pilot suffered no injury and landed his aircraft safely, minus about one-third of his right wing. The target aircraft, flown by our commander, crashed in the western hill country north of Uvalde, Texas, with the CO still in the aircraft.

'In retrospect, the mission was well planned, including the controlling GCI unit that directed all the aircraft involved. The supersonic target aircraft launched first, climbing westwards towards Van Horn, Texas, where it did a 180-degree turn to a heading of approximately 110 degrees at an altitude above 45,000 ft. It then accelerated to supersonic speed at an unknown altitude. The interceptor F-102As launched about five minutes after the target and climbed to an assigned altitude of around 40,000-45,000 ft in an area southwest of Del Rio, Texas, or northeast of Laredo, lined up in staggered echelon formation about ten miles apart. Each interceptor had a separate controller who issued instructions throughout the flight, advising on the position of each interceptor as it approached and initiated the interception profile. Due to the extremely high fuel usage and supersonic speeds, all aircraft returned to base after one intercept. The total mission time was 45 to 60 minutes.

'These supersonic interceptions were performed on a weekly basis for about six months prior to an Operational Readiness Inspection [ORI] by

Some ANG units continued their 1950s practice of displaying their state's name on the fuselage until the U.S. AIR FORCE titling was standardised around 1963. The 182nd FIS, with a simple white-outlined red tail chevron and a patch showing a bird of prey over the Alamo, received F-102s in 1960 and flew them for nine years. With these earlier markings, the squadron competed in the Ricks Trophy race in September 1962 (*Terry Panopalis*)

higher headquarters. They would subsequently be done in daylight hours, usually flying eight missions with four interceptor F-102s and one target aircraft. A kill ratio was based on reading the NADAR tapes [a recording of the pilot's radar scope display and flight data during an interception which could be played back on video equipment], which each aircraft carried, recording the actions of the pilot and the FCS.

'Over the course of time each pilot usually performed ten to 15 supersonic interceptions depending on his availability as a part-time ANG pilot. Full-time ANG pilots employed by the unit would most likely double that number, as they were always available to fill in on any mission when part-time pilots were not available. That is why our commander was the pilot of the supersonic target aircraft on that fateful night. He volunteered to fly as the target.'

The Texas ANG's relative proximity to Convair's Fort Worth plant, where B-58A supersonic bombers were built, provided some other unique training opportunities for F-102 pilots, as Lt Col Trojcak recalled;

'The B-58A had so much technological capability at that time. At Fort Worth it was in close proximity to us for testing its technology against frontline F-102 interceptors. All the interception runs on B-58As were done at around 18,000 ft and at a speed at which we could easily stay with the bomber. They were on a race-track circuit from about Brady, Texas, to Brownsville. We would pull up about four to five miles behind him and continue to close in, using our very good FCS to try and defeat his ECM. It was both a learning experience for the B-58A crew and for us as interceptor pilots.

'It was a wonder to watch in our radar scopes what they were able to do to us. Their favourite trick was to negate every effort we made to close in and get a "fire" indication [on our FCS]. At times we would be driving in on him and everything seemed to be going perfectly. We would get what appeared to be a good "fire" signal but no! When we looked up expecting to find him about a mile ahead, he was not there. He was off to one side or the other by about a mile and we were almost abreast of each other. He could take our [radar] range gate and slowly steer our FCS to one side or the other and still let us get a good "fire" signal – but out in space.

'Now this grizzly old pilot was not to be outfoxed. I learned how to defeat what he was doing to my FCS. I went to Manual control of the

system and kept on driving right up his tail and got a good "fire" signal. As far as I know I'm the only one who repeatedly did that with 100 per cent success. But that was kid's games, and if he wanted [to win] it was very simple. All we would see were four black smoke trails from the B-58A's engines suddenly stopping with the initiation of his four afterburners, after which he just accelerated out of sight. There was no way anyone could stay with him or catch him.

'I flew approximately 20 of these missions, all by day. I did have the chance of one night mission, but I had a maintenance problem and aborted on take-off. Convair sent us a letter of thanks and appreciation for all the information they had learned during our makeshift interceptions, which just consisted of getting in trail with the bomber and having a go at him. I loved the experience and gained a tremendous amount of confidence in my ability and in the F-102 – a great aircraft!'

Although the B-58A had a low radar signature compared with a B-52, it could be picked up on an F-102A's IRST at more than 60 miles head-on and at longer distances over the sea. The IRST could then be used with the radar in a number of modes that prioritised either the radar or IR returns. Using the IRST in this way also helped to defeat ECM emissions from the bomber target.

Lt Col Trojcak recalled that interceptions of high-flying U-2 spy planes were also possible. Theoretically, an F-102's Falcons (or 20 mm gunfire from an F-104A, which could climb slightly higher) would disable a U-2. To make that interception an F-102 pilot would have accelerated to Mach 1.25 at 50,000 ft, pulled up into a snap-up climb and launched the missiles at around 60,000 ft. It was possible to fly an F-102 straight and level at around 58,000 ft.

ANG BUILD-UP

When the 134th FIS of the Vermont ANG converted to 'Deuces' from F-89Js in 1965, it received an F-102A and a TF-102A that had previously been flown from the unit's Burlington International Airport (Ethan Allen AFB) base by the 37th FIS when it was located there from 1957 to 1960. Several former 37th FIS pilots also joined the 134th, and the unit adopted the 'Green Mountain Boys' nickname formerly used by the squadron. It flew 'Deuces' for nine years.

Also in 1965, the 116th FIS 'Dagger in the Ace of Spades' of the Washington ANG traded F-89Js for F-102As at Geiger Field, Washington. It then moved to the F-101B in 1969. A number of other squadrons followed in quick succession during 1966. The 118th FIS 'Flying Yankees' of the Connecticut ANG sandwiched five years of F-102 operations between two periods as an F-100 unit. Its 'Deuces', with their distinctive bird design (adopted in 1969) on their vertical tails, were delivered in January 1966, and most came from PACAF squadrons. Towards the end of the unit's F-102 period the unique décor disappeared as camouflaged examples from USAFE began to feature on the Bradley Field, Connecticut flightline. Some grey-painted aircraft were seen with camouflaged drop tanks during that transitional period of colour schemes.

Capt Roger Moore flew F-102s with the Connecticut ANG and also with the 199th FIS 'Fighting Tikis' of the Hawaii ANG at Hickam AFB. Describing a typical practice interception, he pointed out that, 'While operating the "Deuce" in the attack mode you were "heads down" [in the radar hood] as everything was in Radar or IR mode. We had an optical sight but it was not maintained and was useless. The F-106 did not have an optical sight before they put the gun into it.

'Flights with the Hawaii ANG and Connecticut ANG were identical in being controlled by GCI. One flight I had with the Connecticut ANG was memorable as I was awarded the Air Medal for it. An F-106 operating out of Griffiss AFB, New York State, lost all electrics and I had to lead the pilot home. I planned a visual join-up with him, choosing not to use radar. I got to within about half-a-mile of him and realised that I had about 200 knots of overtake speed, so I did a high-G barrel roll around him and then signalled him to join on my right wing so that I could lead him home.'

The Minnesota ANG's 179th FIS 'Bulldogs' became an F-102 operator from November 1966, having retired its F-89Js. After five years it too transitioned to the F-101B/F at Duluth Municipal Airport. The unit's area of responsibility in the northern USA was indicated by the large areas of high-visibility International Orange paint on the tails and wingtips of its aircraft. The only known colour scheme variations were the camouflage on one ex-32nd FIS example and a one-off test scheme that featured a black and yellow chequered fin on F-102A 56-1345.

The Montana ANG's 186th FIS was another interceptor unit that progressed through various models of the F-94 and F-89 from 1955 before receiving F-102As in July 1966. It became one of the few ANG F-106 Delta Dart units in 1972, still at Great Falls International Airport, and passed some of its F-102s to the Idaho ANG's 190th FIS. The 178th FIS 'Happy Hooligans' of the North Dakota ANG were F-102A recipients during the same period, and it too had a long history as F-94 and F-89 interceptor specialists. The unit's association with the 'Deuce' was colourful but relatively brief, as it received F-101B/Fs from 17 November 1969. The F-102 pilots duly had to adapt to handing most of the responsibility for radar interceptions to a back-seat radar operator, as well as learning to fly a jet that was much harder to handle than the 'Deuce'.

Voodoos also filled the flightlines of the 123rd FIS 'Red Hawks' of the Oregon ANG from March 1971 after its five years as an F-102 unit. This former F-89J squadron had flown 'Deuces' marked with a simple lightning bolt emblem from Portland International Airport since January 1966. Wisconsin's 176th FIS also converted in 1966, trading F-89Js for F-102s in May. In 1969 it concentrated its training into a summer camp at Gulfport Readiness Training Center in Mississippi after six years with only local training.

While some ANG units flew their F-102s for ten years or more, the record for the shortest period of 'ownership' must go to the 132nd FIS 'Maine Bangers' of the Maine ANG, flying from Bangor International Airport. After 15 years flying Scorpions, the unit received F-102s in July 1969, most of them camouflaged examples passed on by the 32nd FIS in the Netherlands. However, a mere four months later the unit was ordered to convert once again, this time to F-101B/Fs, which it then retained for six years. Its F-102s went to the Florida ANG instead.

Two immaculate F-102As (56-1278 and 56-1270) represented the 176th FIS of the Wisconsin ANG at the September 1972 William Tell weapons competition at Tyndall, and their underwing drop tanks were given appropriate markings. When first introduced in 1957, the external fuel tank pylons (an innovation at the time) tended to eject the drop tanks unexpectedly, bringing about temporary restrictions on their use until modifications were made. The squadron numbered its aircraft individually and conspicuously on the red-orange arctic markings that the aircraft retained from their previous ownership by the 317th FIS in Alaskan Air Command (*Author's collection*)

The final ANG 'Deuce' unit was the 102nd FIS of the New York ANG, which had been a KC-97L piston-engined tanker squadron with the Military Air Transport Service prior to switching to F-102s in late 1972. It only kept the Delta Daggers until the spring of 1975, when the 102nd went through another transformation and became an air rescue unit with HC-130 Hercules and HH-3E helicopters. The squadron's F-102 colour scheme, however, was one of the more memorable, featuring a blue and white flash with a stylised bird, often on a drab Vietnam camouflage background.

F-102s completed 17 years with ADC and almost the same time in ANG service – a creditable total for an aircraft that was meant to be a stopgap pending the arrival of the 'F-102B Ultimate Interceptor'. In addition, ANG pilots often made TDY tours with 'Deuce' units in Southeast Asia, and some flew with F-102 squadrons in USAFE and the Far East. By 1967 there were 22 ANG interceptor units, 20 of them with F-102s, which fulfilled NORAD's 1959 plan to have 19 ANG F-102 alert squadrons. However, they were distributed across the USA, rather than focused in the northern states as NORAD had originally intended.

In 1968, a total of 374 of the ANG's 1220 aircraft were F-102s, and it still had 40 F-89Js as additional interceptors in the northeastern part of the USA. ANG squadrons steadily acquired F-102s as they completed service with other units in the Far East and Europe. A number of these units eventually received upgraded 'Deuces' as later models with IRST and other updates became available to squadrons like the 199th FIS of the Hawaii ANG in 1969-70. Individual aircraft would therefore sometimes serve with up to seven different units during their lifetime.

ANG interceptor units, like their regular USAF equivalents, maintained alert status throughout the 1960s, with two aircraft from each squadron always on five minutes' notice to take-off, often from open-ended shelters. Pilots honed their skills with regular exercises and taxing Operational Readiness Inspections. Providing the majority of the continent's air defence was a demanding role, and there were inevitably casualties. Fourteen pilots and 42 F-102s were lost during the ANG's years of F-102 operations. By the early 1970s the normally reliable J57 engines were beginning to age, with cracked compressor cases being the cause of several losses.

Interception practice sorties with other units within their state boundaries were extended by visits to the William Tell competition, where ANG F-102 squadrons were represented on six occasions from 1961 onwards, beginning with the 182nd FIS from Kelly AFB. Sometimes the only ANG participant was an F-102 unit. For example, Pennsylvania's 146th FIS was the solitary ANG representative in 1963's event, and it won the F-102 category. From 1970, when the F-102 had almost completed its frontline service, the 16 ANG squadrons flying the 'Deuce' at that time would compete with each other for four years as the only F-102 contenders. Top prizes went to the 179th FIS in 1970 and to Wisconsin's entry in September 1972 at Tyndall AFB.

CHAPTER SEVEN

LATTER DAYS

In addition to the many early F-102s used to test the 'Deuce', several were involved in other projects, including nine flown by NACA and NASA for research and pilot training. Four were devoted to the Astronaut Proficiency Flying Program at Ellington AFB, where 15 future astronauts used them until faster T-38A trainers arrived in 1964. Test pilot and astronaut Neil Armstrong practiced many dead-stick landings in F-102s as part of the preparation for making unpowered landings in rocket-powered research aircraft such as the cancelled Boeing X-20 Dyna-Soar and the North American X-15, which he flew later.

Fellow X-15 pilot Robert M White also encountered the YF-102 at Edwards AFB and was unimpressed by its slow response rate and tendency to wallow and yaw. After modification, though, he found it to be a 'very fine aircraft'. With fellow test pilot Iven Kincheloe, he flew up to 60 hours per month on the four pre-production examples that they were given to wring out. Intensive flying quickly identified any pieces of equipment with a high failure rate or any minor handling problems that still remained. Part of their job was inducting ADC pilots to the new type, which often meant observing and critiquing their take-offs and landings from the runway control booth at Edwards.

NASA used YF-102 56-0998 as a chase aircraft for the F-106 ejection seat test aircraft, while the Federal Aviation Administration used another Delta Dagger to prepare air traffic controllers for handling supersonic

General Electric used F-102A 54-1398 in 1959 to flight-test its YJ85 turbojet for the Northrop T-38A. The instrumented engine was suspended on a pylon extending from the missile bay, which had its doors cut back to accommodate the test rig. The engine was tested to Mach 1 and 50,000 ft in a 50-hour flight test programme that also included afterburner operation (*Terry Panopalis*)

transport aircraft such as Concorde. General Electric utilised F-102A 54-1398, covered in liberal applications of orange paintwork, to test the YJ85 engine for the T-38A trainer and North American Aviation borrowed TF-102A 55-5032 to develop the AN/APN-114 automatic landing system for military and commercial aircraft. Others found work with the 6520th Test Group and the Air Force Development Test Center.

In 1957 six 327th FIS aircraft were seconded to Operation *Plumbbob* – an extraordinary test of the effects of a nuclear explosion on aircraft in flight. Their pilots were told to fly through the mushroom cloud from a 20-kilton nuclear device at 20,000 ft, simulating a potential wartime scenario. In fact, a shortage of aircraft at that early stage of the squadron's transition to the 'Deuce' left only two jets to make the flight. Their pilots returned intact but the F-102s were too radioactive to be returned to the squadron.

However, the most radical improvements suggested for the F-102 were stillborn as the USAF was already anticipating its successor, the F-106, from the early days of the jet's development. The F-102C or F-102X was proposed in September 1956 as a bridge between the F-102 and F-106 while the latter was still being developed. There were also plans to give the 'Deuce' a tactical strike capability in the hope of a Canadian order. It would have had an uprated J57-P-47 engine to confer a speed of Mach 1.3 and a 3000 ft increase in service ceiling. The AIR-2 Genie would have been added to the armament of four Falcons, operated by a more capable MG-14 FCS. Convair made partial YF-102C modifications to 53-1806 and the frequently adapted test-bed 53-1797 to demonstrate the improvements, but no USAF interest was forthcoming. An RF-102 tactical reconnaissance proposal did not advance beyond a paper study.

THE HUNTER HUNTED

Although Firebee drones made good high-speed targets for air-to-air missile practice, or ground-to-air gunnery and missiles, they lacked the manoeuvrability to simulate fighter-type adversaries in air combat training. The USAF initially intended to use surplus F-104s as full-scale targets (FSTs), and although cost overruns terminated that programme, the QF-104s had at least demonstrated the value of using a high-performance aircraft to improve both the efficiency of missiles like the AIM-7 Sparrow and AIM-9 Sidewinder and the quality of pilot training to fire them effectively.

Both missiles had performed poorly in real combat situations in Vietnam compared with their early tests in ideal conditions against easier Firebees. The F-102 was a convincing 'MiG simulator' in size, performance and in its radar and IR signatures. Moreover, nearly 400 were in storage at the Military Aircraft Storage and Disposition Center (MASDC) at Davis-Monthan AFB by 1972 after the type's withdrawal from most ANG units. The Delta Dagger was, therefore, an obvious choice for conversion to either piloted target configuration (QF-102A) or unmanned drone use (PQM-102A or the more simplified PQM-102B).

In April 1973 the Sperry Rand Corporation, which had considerable experience in drone technology, was given a contract to convert five aircraft. The first flew on 10 January 1974, and its success led to contracts

for 65 PQM-102As and 145 PQM-102Bs. The aircraft were restored to flying standard and test-flown at the MASDC, after which ferry pilots flew the selected F-102As to the Sperry Flight Systems Division at nearby Phoenix, where they were stripped down and had drone wiring installed, along with actuators, autopilots, telemetry and computer hardware. Radar and FCS were removed and self-destruct equipment (including a 25-lb explosive charge) fitted, together with scoring systems – manufactured by Cartwright or Motorola – to record missile performance. Smoke emission equipment was also fitted to ease visual identification for the scoring cameras or other intercepting aircraft.

The piloted version had its control electronics package fitted behind the cockpit, while the drone PQM-102A/Bs had these systems installed in the cockpit. It could be removed quickly if there was a need to pilot the aircraft conventionally – on a delivery or ferry flight, for example. The drone could dispense countermeasures in the form of chaff and flares, fly at ranges up to 200 miles if radar guidance allowed and pull 8 g in manoeuvres. Its flare system (AN/ALE-28) was located eight inches below the elevon control wires running into the fuselage. On a piloted FST mission Fred Whitten ejected a flare but it lacked a delayed fuse, ignited in the flare tube and set off all the other flares. Burning at 3000°C, they soon melted the control cables, forcing him to eject.

In 1975 the Sperry organisation was producing four *Pave Deuce* PQM-102A conversions per month, and in 1978 PQM-102B conversions began at the company's Litchfield Park facility near Phoenix. Pilots collected completed drones and flew them to Tyndall AFB, where they were taken on charge by the 4756th Test Squadron. From July 1981 that responsibility passed to the 92nd Tactical Aerial Targets Squadron, also at Tyndall.

Although the drones were originally operated from the Florida base's main runway, safety considerations demanded the construction of a special drone-way complex in the early 1970s. It had an 8000-ft runway five miles from the main Tyndall base that allowed drones to take-off straight out to

Still showing traces of its former California ANG ownership on its rudder, PQM-102A 57-0781 '634' had passed through the drone conversion programme in February 1975 following its retirement by the 196th FIS the previous year. With a paint scheme seriously degraded by the Arizona sun while in storage with the MASDC, the pilotless 'Deuce' complete with a Halloween pumpkin logo cruises over the Holloman AFB range (*USAF*)

sea over the Gulf of Mexico. Departures were controlled from the Mobile Control Station (MCS) van, located 1000 ft behind the drone. The vehicle was equipped with radar and had two controller stations (one for vertical pitch and engine power, the other for elevation and direction with elevons and rudder) and a launch commander station. All three controllers had to be former USAF pilots, while the launch controller had to be current on the F-102.

Before take-off, the PQM-102 was started by a technician and then control passed to the launch control operator (LCO). A pre-take-off checklist of the controls was done and the self-destruct circuit was armed and checked. The drone was then launched once the fighters were in position to engage it. The 'Deuce' took off in afterburner, which was shut down at 280 knots, and speed was held at 300 knots and full power, using autopilot pitch to maintain that speed. The LCO then passed control to the MCS once radar contact was established.

Fighters engaging the drones often used the standard intercept tactic that saw the 'Deuce' targeted by a Sparrow head-on, followed by a rear attack with AIM-9s. Such attacks used up to four of each missile type, with their proximity fuses removed so that direct hits were necessary to bring the drone down. The Range Safety Officer used the fighters to radar-sweep the chosen area of the Gulf of Mexico before an interception took place so that a 'shoot box' could be established where it was safe for debris to fall without posing a danger to shipping.

During a 55-minute flight, the controllers obviously made the drone as hard a target as possible through extreme manoeuvres, use of countermeasures and traditional fighter pilot skills. There was a back-up control system, but if a drone became uncontrollable the Range Safety Officer could transmit a UHF signal that detonated the Mk 48 self-destruct charge installed behind the cockpit and blew the aircraft in half. Self-destruct, requiring four switch movements, would be triggered by an un-commanded manoeuvre such as a sudden rapid roll that indicated loss of overall control.

Some were destroyed on their first sortie or crashed on take-off (in the case of sharkmouth-decorated 56-1263), while others survived up to 48 missile strikes (56-1426). One PQM-102B lasted for 20 flights, but most averaged only four. If it seemed that a drone could be recovered safely, an aerial inspection was made by another aircraft. If it was badly damaged while supporting US Army surface-to-air missile training at White Sands Missile Range, New Mexico, a landing could be attempted on an emergency runway at the facility. Some were patched up after very severe damage. Returning drones at Tyndall engaged an arresting cable halfway down the runway.

The drone 'Deuces' were used as targets during William Tell competitions and for testing the US Army's ground-to-air missiles, including Patriots, Stingers and Chaparrals. They were also expended during F-15 Eagles missile armament trials. When conversions ended in 1981 Sperry had worked on 215 F-102As, and they were replaced as full-scale targets by QF-100 conversions of the Super Sabre, of which 400 were also in desert storage. The last of 760 *Pave Deuce* missions was flown on 30 June 1986.

EUROPEAN DEUCES

From the US Century Series fighters, both the F-100 and F-104 saw service with many air forces while the more sophisticated F-105 and F-106 were confined to USAF use only. Towards the end of its career in the ANG, the F-102 found places in just two foreign air forces under the Military Aid Program for NATO requirements. In November 1967 Project *Peace Violet* began, training six instructor pilots for the *Türk Hava Kuvvetleri* ahead of their receipt of ex-USAF F-102As. In June 1968 Ling Temco Vought in South Carolina began contract work to refurbish 22 F-102As from early production batches.

On 30 September 1968 a similar 26-week course began for six Greek air force instructors. At Crestview, Florida, the Fairchild Industries Aircraft Service began overhaul work on the remainder of the 69 F/FT-102As for the two countries. Most came from the California ANG's two squadrons, with others being drawn from ANG units in Montana, Connecticut and Texas. In order to commence the training programmes seven TF-102As were supplied directly from US squadrons.

The first batch made its delivery flight via Newfoundland, Iceland, Scotland and Ramstein AB, arriving at Murted AB in Turkey to begin operational service in June 1968 after servicing at Construcciones Aeronauticas SA in Spain. They were issued to the 142nd (originally the 144th) *Filo* (All-Weather Fighter squadron) and the 182nd (re-numbered from the 183rd) *Filo* at Murted/Ankara, where they served alongside the F-104-equipped 141st *Filo*. The 182nd *Filo*, which was originally based at Diyarbakir AB, converted to the F-104G towards the end of 1974 and its now surplus F-102s provided spare parts for the 142nd *Filo*'s 'Deuces'. In all, 45 aircraft had been received by the end of 1969, including up to ten TF-102As.

The *Elliniki Polemiki Aeroporia* (Hellenic air force) received 19 F-102As and five TF-102As from 1969 onwards for its 114th *Pterix* (Combat Wing) assigned to the country's Tactical Air Command at Tanagra AB, where they were in use until 1978. They replaced surplus USAF F-84Fs.

F-102A-55-CO 56-0981 arrived in Greece in October 1969 after refurbishment at the Fairchild Aircraft Service Division. It was used by the 114th *Pterix* of the *Elliniki Polemiki Aeroporia*'s Tactical Air Command at Tanagra AB. The aircraft is currently in open storage at Elefsis AB, northwest of Athens (*Terry Panopalis*)

F-102A 54-1382 was delivered to the *Türk Hava Kuvvetleri*'s 144th *Filo* at Murted AB in May 1969, and it was later transferred to the 183rd *Filo* (later re-numbered the 182nd *Filo*) at Diyarbakir AB. A US arms embargo after the 1974 conflict with Greece over Cyprus made spare parts so scarce that this aircraft was withdrawn in June 1979. The national markings seen here were later replaced by roundels over camouflage (*Author's collection*)

Greece and Turkey were virtually at war when their air forces were converting to F-102s. One of the key flashpoints between the two countries was the Mediterranean island of Cyprus, which has been effectively partitioned into Greek and Turkish regions since 1974 when Turkey invaded it twice to protect Turkish residents from a suspected plan by the Greek ruling junta to unite the island with Greece. The second invasion, and the full-scale military conflict that ensued, resulted in Turkey controlling 40 per cent of the island. Turkish air action involved their F-100 and F-104G fighter-bomber units as well as the F-102As. Northrop F-5s were also used for tactical bombing.

In opposition to the Turks, the Hellenic air force fielded up to 350 fighters, including its first F-4 squadron, although the Phantom IIs did not participate. On 21 July 1974 a Greek F-5A pilot claimed a Turkish F-102A shot down. Turkish sources note that heavy fighting took place on 22 July, including 122 attack sorties and 23 air defence missions. F-102As flew 109 air defence sorties during the conflict. A Greek F-5A reportedly crashed while attempting to intercept the Eskisehir-based F-102A flown by Capt Onur Sitki of the 142nd *Filo*, although some Turkish reports attributed the loss to an AIM-4 Falcon fired by the 'Deuce'. 142nd *Filo* F-102A 55-3413 crashed on landing that same day and was destroyed, although its pilot escaped injury.

The following day another Turkish F-102A (55-1403) crashed on take-off, killing 1Lt Cinar. The Turks also lost five F-100C/Ds, an F-104G and a reconnaissance RF-84F during the three-day conflict. A US arms embargo following the clash ruled out replacement American military aircraft and severely reduced the serviceability of the F-102 fleets of both countries. Greece turned to France for 40 Mirage F1CGs instead. From mid-1979 Turkey used its F-104G and F-100C fighters in the interceptor role and retired its F-102s, although many had already been lost in accidents. Several F-102s were sold to Saudi Arabia as training airframes for maintenance workers.

Despite 23 years of Cold War and hot war service, the F-102 was hardly ever involved in aerial combat. Nevertheless, it provided a formidable deterrent capability throughout much of that time.

APPENDICES

COLOUR PLATES

1
F-102A-45-CO 55-3402 of the 327th FIS/64th AD, George AFB, California, 1958

The 327th used these striking colours while at George AFB as the first operational F-102 squadron, changing to the FS 12197 International Orange standard tail colours when it moved to Thule AB, Greenland, later in 1958. As a relatively early production example, this F-102A lacks the IRST, arresting hook and SAGE antennas of later aircraft, although it has production-style intakes and the taller tail. 55-3402 went on to fly with the 40th FIS at Yokota, Japan, and the 118th FIS of the Connecticut ANG until May 1970, when it was placed in storage at the MASDC.

2
F-102A-41-CO 55-3368 of the 16th FIS/51st FIW, Naha AB, Okinawa, 1960

Part of PACAF's Thirteenth Air Force, this squadron was charged with the air defence of Okinawa. It exchanged F-86D for F-102As in 1959 at Naha AB, and flew 'Deuces' until 1964 when the unit was inactivated and its aircraft were sent to the Hawaii ANG's 199th FIS in Project *Clearwater*. Previously, it had operated with the 11th and 2nd FISs in ADC. The aircraft's career with the Hawaiian squadron ended in October 1973 when it was struck off charge at Hickam AFB. Painting wing fences in squadron colours was a frequent identifier, although they were most often red.

3
F-102A-45-CO 55-3392 *ROAD Runner II Beep Beep* of the 40th FIS/41st AD, Yokota AB, Japan, 1961

This squadron's connections with the Far East dated back to 1942, and it became a Fighter Interceptor Squadron in 1950, flying F-80Cs during the Korean War. At Yokota AB from 1954, the 40th converted from F-86Ds to F-102As in 1960 and flew them until 1965, when they were returned to the USA in Project *Clearwater*. This example had left a year earlier to join the 118th FIS of the Connecticut ANG, having originally served with the 11th and 318th FISs. Following its retirement by the ANG, the jet was transferred to the *Türk Hava Kuvvetleri*'s 191st (later 142nd) *Filo* in October 1968 and eventually became a preserved gate guardian at Akinci AB, Turkey.

4
F-102A-70-CO 56-1294 of the 317th FIS/5070th ADW, Elmendorf AFB, Alaska, 1960

The 317th FIS required up to 50 F-102As to patrol its vast area of responsibility over the extreme northwest of the USA where it neared Siberia. The unit's first eight months with 'Deuces' (when the jet's were adorned with a simple white lightning bolt tail marking) were spent at McChord AFB, Washington, but in 1957 it was transferred to Alaskan Air Command at Elmendorf AFB. With its aircraft being painted in typical arctic markings, the 317th guarded the area for 12 years, intercepting many Soviet aircraft. Some F-102s, including this one, had the serial number placed low on the tail, and they also had red elevons – a few had International Orange areas extending forward under the rear fuselage. This 'Deuce' flew with the 176th FIS of the Wisconsin ANG from 1972 until 1974, when it entered storage at MASDC. The aircraft was subsequently converted into PQM-102B '740' and shot down over the Gulf of Mexico by a missile on 5 June 1980.

5
F-102A-55-CO 56-1006 of the 431st FIS/86th AD, Zaragoza AB, Spain, April 1962

Only two years (1961-62) of this aircraft's long service life were spent in Spain with the 65th AD's 431st FIS, and it is seen here painted in the squadron commander's colours. After exchanging F-86Ds for F-102s in 1960, the squadron switched to F-4s in March 1964 after less than four years and became a tactical fighter squadron. This example had previously been 'owned' by the 2nd and 48th FISs and the 4780th ADW at Perrin AFB. After Spain it served with the 525th FIS at Bitburg AB, the 32nd FIS at Soesterberg and then with three ANG units of the Arizona, North Dakota and South Carolina ANGs. In September 1978 it became PQM-102B '713' and was shot down over the Gulf of Mexico in December 1980.

6
F-102A-51-CO 56-0960 *RED-STRIPED RASCAL* of the 4th FIS/39th AD, Naha AB, Okinawa, 1960

Initially serving with the 31st and 2nd FISs following its delivery to ADC in 1956, this aircraft, which had an arresting hook but no barrier probe, was issued to the 4th FIS when it transitioned to the F-102A from the F-86D in 1960. The 4th flew 'Deuces' until 1965, when its aircraft were returned to the USA in Project *Clearwater*. This example, adorned with squadron commander's stripes behind the cockpit, then went to the South Dakota ANG's 175th FIS, followed by the 118th FIS of the Connecticut ANG, before entering storage in May 1970 and eventually being scrapped in February 1975.

7
F-102A-55-CO 56-1032 of the 32nd FIS/86th FIW, Camp New Amsterdam, Soesterberg AB, the Netherlands, 1961

Like most F-102s, this aircraft flew with many squadrons – in 56-1032's case seven (starting with the 498th FIS 'Geiger Tigers') – before it was converted into a PQM-102B drone in May 1979 and expended six months later. During its five years in Holland with the 32nd FIS the jet wore the early 'sunburst' tail markings seen here, and was later re-decorated with the green tail-band and red, white and blue squadron commander's stripes (the jet was selected for this role because of its serial number) and airbrake flash with which it attended the 1966 Paris Air Show. By then it had also received an IRST 'ball' and SAGE antennas.

8
F-102A-95-CO 57-0907 of the 460th FIS/337th FG, Portland International Airport, Oregon, September 1962

Decorated with the squadron's distinctive 'Cave Tigrim' motto and emblem, 57-0907 was one of the F-102s issued to the 460th FIS in 1958 as replacements for its F-89 Scorpions. The unit retained the 'Deuces' until it was inactivated in March 1966. The 460th

was reactivated in September 1968 and issued with F-106 Delta Darts, which it kept until being inactivated once again in July 1974. Finally, it briefly served as an F-106 training unit in 1982. The squadron flew this F-102A (the third to last Delta Dagger built by Convair) from 1958 to 1962, after which it became a trainer for the 4780th ADW at Perrin AFB before giving ANG service with the South Carolina and California units. Retired in 1971, 57-0907 became one of the last PQM-102B drones as '841' in July 1981.

9

F-102A-60-CO 56-1009 of the 48th FIS/Washington Air Defense Sector, Langley AFB, Virginia, May 1960

A former F-94C unit, the 48th FIS upgraded to F-102s in March 1957 and adopted a spectacular colour scheme, which in this case also includes command stripes (denoting the jet's assignment to the CO) on the rear fuselage. It transitioned to F-106s in 1960, when this 'Deuce' was passed on to the Hawaii ANG's 199th FIS prior to serving with Arizona and California ANG units. 56-1009 was retired to MASDC in January 1970.

10

F-102A-70-CO 56-1237 of the 526th FIS/86th AD, Ramstein AB, West Germany, 1962

This F-102A, assigned to unit CO Lt Col R J Rankin (as noted on the nose of the jet, along with groundcrew names in two red 'Deuce' silhouettes), was operated by the 526th FIS between 1962 and 1969 following previous use by the 332nd and 482nd FISs. It was lost in a mid-air collision with F-102A 56-1263 near Ingwiller, in northeastern France, on 14 July 1969, with the latter aircraft surviving the incident with only modest damage. Like other USAFE F-102 units, the 528th changed its 'sunburst' tail markings for a single horizontal stripe in 1965.

11

F-102A-60-CO 56-1060 of the 525th FIS/86th AD, Bitburg AB, West Germany, 1961

As with the 526th FIS, the 525th also used 'Deuce' silhouettes ahead of the air intakes to display the pilot's name (in this case 1Lt Ray Roberts) and, below it, the crew chief (A1C Tillery). 'Sunburst' tail markings gave way to a single blue band in 1965. The 525th was the first USAFE F-102A unit, and it inherited 56-1060 from the 5th FIS in 1958. The aircraft crashed five miles from Hahn AB, after hydraulic systems failure on 18 June 1961, its pilot, squadron CO Lt Col John B Anderson, having made several unsuccessful attempts to land at night in terrible weather. Unable to line the Delta Dagger up with the runway, he was forced to eject.

12

F-102A-60-CO 56-1080 of the 496th FIS/86th FIW, Hahn AB, West Germany, 1964

The second USAFE unit to transition from F-86Ds to F-102s, the 496th flew 'Deuces' for more than a decade before handing its surviving aircraft over to the 194th FIS of the California ANG in 1970. 56-1080 had seen previous service with the 318th, 82nd and 431st FISs prior to its spell with the 496th – it also briefly flew with the 497th FIS, before returning to the 496th FIS. It was destroyed in a ground fire caused by an oil leak whilst parked on the ramp at NAS Lemoore, California, in July 1971.

13

TF-102A-35-CO 55-4045 of the 64th FIS/325th FW, McChord AFB, Washington, 1957

This squadron received 55-4045 straight from the factory in 1957 and transferred it to the 318th FIS later that year. It then flew with the 431st FIS (1963-64) and 496th FIS (1966-69) in USAFE, before spending four years with the 196th FIS of the California ANG. Entering storage in May 1974, it met an ignominious end as a target for the US Army on the Fort Bliss Range in Texas the following year.

14

F-102A-95-CO 57-0870 of the 57th FIS/Air Forces Iceland, Keflavik AB, Iceland, 1972

Although this aircraft served with the 57th FIS for only a year in 1971-72, the 'Black Knights' were equipped with F-102s longer than any other unit. It also proved to be the most successful 'Deuce' squadron when it came to intercepting intruders snooping around Iceland. Previously operated by the 482nd FIS, 57-0870 later flew with the 157th FIS of the South Carolina ANG and the 196th FIS of the California ANG following its brief spell with the 57th. One of the earliest 'Deuces' to pass through the PQM-102A conversion programme, in 1973, as '604', the aircraft met its end over the White Sands Test Range in December 1974.

15

F-102A-65-CO 56-1208 of the 102nd FIS/106th FG, New York ANG, Suffolk County Airport, Westhampton Beach, New York, September 1974

This was the final squadron to operate 56-1208, which began its service life with the 82nd FIS at Travis AFB in 1958 and then moved to the 27th FIS. It served with the latter unit until 1964, when the jet was transferred to the 526th FIS at Ramstein AB. Upon returning to the USA in 1967, 56-1208 was supplied to the 186th FIS of the Montana ANG, before finally joining the 102nd FIS. The squadron's distinctive markings were applied over the aircraft's TO-1-1-4 camouflage. In December 1975 the jet became PQM-102A '654', and it duly crashed on 17 November 1978 after control failure while landing at Holloman AFB.

16

F-102A-65-CO 56-1157 of the 509th FIS/405th FW, Don Muang Airport, Bangkok, Thailand, 1962

This 'Deuce' began its career in the even more colourful markings of the 48th FIS, and then flew in Arctic colours with the 509th FIS from Goose Bay Airport, Newfoundland. The squadron's detachments to Don Muang Airport in 1961 marked the beginning of F-102A air defence activities in Thailand. This aircraft remained in 509th FIS service until July 1970 when F-102s were withdrawn from Far East units. Hard-ridden examples including this one were scrapped at Itazuke AB, Japan.

17

F-102A-41-CO 55-3366 '*Sly Mongoose*' of the 199th FIS/ 154th FIG, Hawaii ANG, Hickam AFB, Hawaii, 1971

This long-serving, much travelled 'Deuce' started out with the 11th FIS in Minnesota and subsequently flew with the 2nd FIS in New York State and the 16th FIS in Okinawa prior to joining the Hawaii ANG in 1966. The squadron's F-102s provided air defence for the Hawaiian Islands until 1976. This aircraft is now displayed at Hickam AFB.

18
F-102A-45-CO 55-3419 of the 118th FIS/103rd FG, Connecticut ANG, Bradley Field, Windsor Locks near Hartford, Connecticut, 1970

The 118th FIS inherited this F-102A from the 40th FIS in Japan in 1966, the aircraft having originally commenced frontline service with the 327th FIS at George AFB ten years earlier. Also briefly assigned to the 47th FIS in the late 1950s, 55-3419 was amongst the F-102s issued to 'The Flying Yankees' as replacements for their F-100As in January 1966. The unit kept the 'Deuces' for five years before reverting to Super Sabres and becoming a tactical fighter squadron once again. The 118th's distinctive 'bird' marking, applied in 1969, was generally considered to be one of the most innovative in respect to the way it complemented the aircraft's distinctive shape. 55-3419 was retired in November 1971 and subsequently ended its days as a ground trainer at Wright-Patterson AFB.

19
F-102A-80-CO 56-1448 of the 182nd FIS/149th FIG, Texas ANG, Kelly AFB, Texas, 1961

Previously assigned to the 18th FIS at Wurtsmith AFB and the 116th FIS of the Washington ANG, this aircraft joined the 182nd FIS – a former F-86L unit and one of two ANG squadrons required to defend the huge area of Texas and the Gulf of Mexico – in July 1960. It flew with that unit for a number of years before being passed on to the 196th FIS. In January 1970 the fighter was flown to the MASDC for storage, and it was eventually scrapped there some years later. ANG units were allowed to display the name of their state rather than the 21-inch Insignia Blue 'U.S. AIR FORCE' titling on their aircraft until 1963.

20
F-102A-90-CO 57-0806 of the 196th FIS/163rd FIG, California ANG, Ontario International Airport, California, 1972

The California ANG was allocated two F-102A squadrons in order to adequately cover its large geographical area and Pacific coastline. Joining the 196th FIS from the 123rd FIS of the Oregon ANG in 1971, 57-0806 remained with the squadron until its F-102s were replaced by Cessna O-2A/B Super Skymasters in 1975 when the unit became the 196th Tactical Air Support Squadron. 57-0806 was duly sent to the MASDC for storage, where it remained until it joined the PQM-102B conversion process as '734'. The aircraft was shot down by a missile during a drone flight from Tyndall AFB in March 1981.

21
F-102A-15-CO 53-1802 of the 190th FIS/124th FG (Air Defense), Idaho ANG, Boise Air Terminal, Idaho, 1971

This aircraft (and the F-102 depicted in the previous profile) was one of at least 33 F-102s re-finished in aluminised acrylic lacquer in place of the standard FS 16473 Aircraft Gray while receiving maintenance at the Fairchild Aircraft Company's Crestview, Florida, facility in 1969-70. This very early production model F-102 started its career as a JF-102A with the Air Research and Development Center in 1957 before PACAF service with the 16th FIS and Arctic patrols with the 317th FIS. 53-1802's relatively brief period with the Idaho ANG began and ended in 1971 when it was sent to the MASDC in May of that year and eventually scrapped six years later. Despite the 'Deuce's' early origins, it had been updated with IRST, SAGE, an anti-collision beacon and arresting gear by the time it served with the 190th FIS.

22
TF-102A-45-CO 56-2372 of the 178th FIS/119th FIG, North Dakota ANG, Hector Field, Fargo Municipal Airport, 1967

This TF-102A, from the final production batch, began its service life at Perrin AFB training pilots with the 4756th ADW. It then flew with two ANG units, namely the 178th and the 196th FISs, until 1972. It has SAGE antennas but no IRST. The curved extension to the FS 17083 Black radome colour was fashionable in ANG 'Deuce' units during the late 1960s. Retired to the MASDC in April 1972, 56-2372 was scrapped in February 1976.

23
F-102A-55-CO 56-0981 of the 152nd FIS/162nd FIG, Arizona ANG, Tucson International Airport, Arizona, March 1969

This F-102A travelled the world, from Alaska with the 317th FIS to Youngstown, Ohio, with the 86th FIS. It then moved to Hawaii for the 199th FIS followed by Arizona for the 152nd FIS, still without IRST or SAGE installations but displaying a Distinguished Unit Citation ribbon on its tail. In October 1969 56-0981 was delivered to Greece as the oldest 'Deuce' to serve with the 114th *Pterix* at Tanagra AB. It was subsequently withdrawn and remains in open-air storage at Elefsis AB.

24
F-102A-90-CO 57-0855 of the 134th FIS/158th FIG, Vermont ANG, Burlington International Airport, Vermont, 1970

After service with the 482nd FIS at Seymour Johnson AFB, North Carolina, until 1965, this aircraft was taken over by the Vermont ANG's 134th FIS. This squadron inherited the 'Green Mountain Boys' (the local militia who captured Fort Ticonderoga from the British in 1775) title from the 37th FIS, which had previously been based in Vermont. The unit's tail flash was changed from red to a more suitable dark green in late 1969. 57-0855 went on to fly with the New York ANG and was eventually shot down in 1977 as PQM-102A '617'.

25
F-102A-90-CO 57-0847 of the 146th FIS/112th FIG, Pennsylvania ANG, Greater Pittsburgh (Coreopolis) Airport, Pennsylvania, 1973

The 146th FIS sported one of the most eye-catching ANG colour schemes of the F-102 era, introduced in 1972 to replace a previous, simple red tail chevron. 57-0847 initially served with the 482nd FIS from 1962, prior to joining the South Carolina ANG's 157th FIS in 1965. The Pennsylvania ANG passed it on to the Wisconsin ANG's 176th FIS in 1974, and it was eventually retired by the unit to the MASDC. The F-102 remained here in storage until it was converted into PQM-102A '665' in February 1977 and shot down by a missile over the White Sands Test Range in August 1979.

26
F-102A-90-CO 57-0823 of the 116th FIS/141st FG, Washington ANG, Geiger Field, Washington, 1967

This aircraft has commander's stripes for the squadron 'boss', Col Charles E Nelson (whose name was also on the nose-wheel door), and the 116th FIS insignia on its intake. The jet's previous career extended back to the 329th and 482nd FISs and the South Carolina ANG's 157th FIS. Following its time with the 116th FIS, the fighter also flew with the 146th FIS from 1972 and, finally, the Oregon ANG's 123rd FIS. In June 1975 57-0823 was converted

into PQM-102A '648' and eventually shot down by a test missile on 29 August 1978.

27
F-102A-75-CO 56-1420 of the 64th FIS/405th FW, Da Nang AB, South Vietnam, 1967

This 'Deuce' originally flew with the 64th FIS from Hamilton AFB, California, before service with the 327th FIS and then the 318th FIS in 1958. It had returned to the 64th FIS by 1967 and adopted the dull, basic camouflage needed for Vietnam service, with PE tail-codes having been added by late 1969. After many detachments to Tan Son Nhut and Da Nang AB, as well as airfields in Thailand, the fighter was withdrawn from service and scrapped at Itazuke AB in July 1970.

28
F-102A-95-CO 57-0864 of the 64th FIS/405th FW, Da Nang AB, South Vietnam, 1969

The 64th FIS took over this Delta Dagger from the Perrin AFB-based 4780th ADW. It had previously flown with the 456th FIS of ADC and, from 1964, with the 82nd FIS at Travis AFB. Adopting the 64th FIS's PE tail-codes in 1968, 57-0864 was later re-coded PK for the 509th FIS at Clark AB and finally scrapped at Naha AB in March 1971.

29
F-102A-45-CO 55-3389 of the 144th *Filo*, *Türk Hava Kuvvetleri*, Murted AB, Turkey, 1970

A veteran on many ADC units including the 327th, 323rd and 318th FISs, this 'Deuce' was then used by the 4780th ADW for training until 1964, when it was transferred to the 111th FIS of the Texas ANG. After a final USAF assignment with the 196th FIS of the California ANG, it was transferred to the *Türk Hava Kuvvetleri* in September 1969 for its 144th *Filo*. The unit, renamed the 182nd *Filo* in 1973, initially applied the original square national insignia to its aircraft, although these were later replaced by roundels. Like the remaining 39 F-102s supplied to the *Türk Hava Kuvvetleri*, 55-3389 had been placed in open storage by 1978 due to a lack of spare parts.

30
TF-102A-40-CO 56-2327 of the 114th *Pterix*, *Elliniki Polemiki Aeroporia*, Tanagra AB, Greece, 1974

Formerly operated by the 37th FIS from Vermont in 1957, the 331st FIS at Webb AFB and the 196th FIS of the California ANG from 1967, this aircraft was delivered to the *Elliniki Polemiki Aeroporia* in September 1969. It was withdrawn from service in 1978 and later stored at Elefsis AB.

F-102A-90-CO 57-0798 (with 57-0796) from the 325th FIS have the 327th FG's insignia on their tails and fluorescent orange stripes for ADC's post-Cuban Missile Crisis Exercises *Swift Strike III* and *Southern Tip* at McGuire AFB in July and August 1963, respectively. 57-0798, with a replacement rudder in this image, crashed near the unit's base at Truax Field, Wisconsin, on 16 October 1964 (*Terry Panopalis*)

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Front Cover
37th FIS F-102A-35 54-1400 climbs for altitude above the mountainous terrain of northeastern USA during a practice interception mission from Ethan Allen AFB, Vermont. The squadron, nicknamed the 'Green Mountain Boys', previously flew its air defence mission with similarly marked F-86D Sabres prior to converting to the F-102A Delta Dagger from December 1957. The unit's first batch of early production aircraft was delivered from Convair's factory in San Diego, California, and in 1959 the 37th passed most of those jets to USAFE units in Germany – it received newer models from the 498th FIS 'Geiger Tigers' as replacements.

Although the 37th was not based in Alaska or Greenland, the squadron liberally applied red-orange 'arctic' markings (including unusual diagonal wing paintwork) to its aircraft as they frequently flew over Canadian territory to intercept intruders. This particular F-102 was assigned to the unit commander, Maj Francis Peters, known as a quiet man but a genuine fighter pilot who flew missions at every opportunity. Under his leadership, the squadron had an extended period of accident-free flying. It duly received a Flight Safety Certificate for this achievement, which came at a time when F-102 accidents were commonplace elsewhere. The squadron also beat the 27th FIS in a 'shoot-out' to represent the 32nd Air Division at the William Tell weapons competition, although operational readiness requirements subsequently meant that the unit could not participate in the exercise.

54-1400 had a fairly typical service history for an F-102A, being flown by several frontline units prior to moving to the Air National Guard. After its 37th FIS use, the jet was taken over by the 327th FIS – the first operational Delta Dagger squadron – at Thule AB, Greenland. It was then reassigned to the 496th FIS, adopting the unit's black and yellow sunburst tail markings while at Hahn AB, West Germany. The fighter then returned to the USA in 1966 for service with the Montana ANG's 186th FIS, prior to being posted to the 190th FIS, Idaho ANG, in 1968. It was retired to Davis-Monthan AFB, Arizona, for storage in March 1970 and eventually scrapped in February 1977 (*Cover artwork by Gareth Hector*)

Title Page spread
A testament to the longevity of the 'Deuce', F-102A-5-CO 53-1793 was the fourth Delta Dagger to leave the production line – it was delivered to the USAF in the summer of 1955. After many updates and service with four other squadrons, it saw combat in Vietnam with the 509th FIS until struck off charge at Clark AB in October 1965 (*USAF*)